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# unasylva

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An international journal of forestry and forest industries

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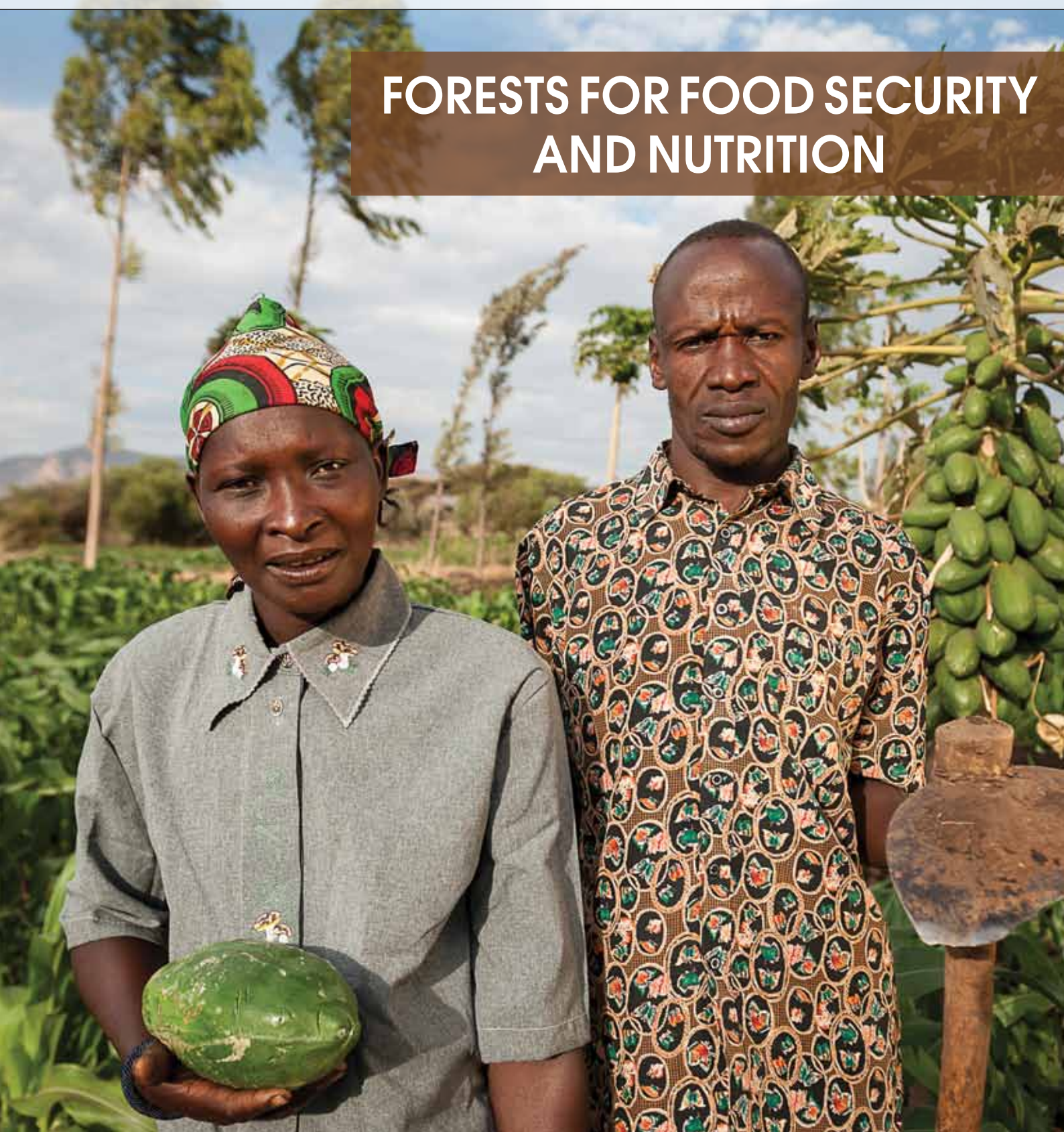
## FORESTS FOR FOOD SECURITY AND NUTRITION



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CFS
Committee on World Food Security

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**Cover:** Two farmers stand in their agroforestry plot in Kenya, the woman holding a papaya fruit. Forests and trees outside forests are increasingly recognized as essential for global food security.
This image by Alana Holmberg won the UN-REDD Programme photo contest, "REDD+ for food security"

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# Forests for food security and nutrition

Ensuring food security and nutrition has always been at the heart of FAO's work. The Organization's constitution asserts that FAO's member nations are determined, among other things, to ensure "humanity's freedom from hunger". FAO's Director-General, José Graziano da Silva, wrote recently that "ending extreme poverty and hunger is not merely desirable; it is the indispensable foundation of a new global society that is both open and fair".

Food security requires healthy, diverse ecosystems, and forests and trees outside forests therefore have an important role to play. To explore this role, FAO and its partners brought together, in May 2013, more than 400 experts from governments, civil-society organizations, indigenous and other local communities, donors and international organizations from over 100 countries for the first global conference to specifically address the role of forests and trees outside forests in food security and nutrition – the International Conference on Forests for Food Security and Nutrition. This edition of *Unasylva* presents articles arising from that conference.

Several articles stress the need to approach food security intersectorally and at the landscape scale. T. Padoch and C. Sunderland, for example, say that more research is needed into ways of better integrating forests, trees and agricultural production in landscapes. While diverse, integrated landscapes ("land-sharing") are the norm in smallholder farming systems, they are being replaced by methods that segregate (and simplify) landscapes into "conservation" and "production", called "land-sparing". The authors argue that replacing land-sharing with land-sparing risks the loss of valuable traditional knowledge and could also reduce the resilience of smallholders to change.

According to J. Mohamed-Katerere and M. Smith, ecosystems, including forests, provide many goods and services that underpin food production. The authors advocate an "ecosystem-aware" approach to food-security policy-making that aims not only to alleviate hunger in the short term but also to ensure the capacity of ecosystems to support food production in the face of shocks and stresses. Diversity – of ecosystems, biota and livelihoods – is one of the keys here.

R. Jamnadass and his co-authors explore the role of agroforestry – the integration of trees with annual crop cultivation, livestock production and other farm activities – in food security and nutrition. More than 1.2 billion people practise agroforestry worldwide, but its role in supporting the food and nutritional security of the rural poor is still poorly documented. More research is needed to better target interventions, and more attention is needed on the domestication of forest food species to harness their huge potential.

An article by A. Bertrand and co-authors looks at the increasing demand for forest foods, especially wild meat, in urban centres in Benin. This increasing demand, say the authors, represents an opportunity for entrepreneurs and rural producers, but there is an urgent need for a new legal and administrative framework that promotes sustainable forest management and the domestication of forest animals for meat production.

L. Stloukal and co-authors examine the role of gender in the food security (or insecurity) of rural people. The disadvantages faced by women in developing countries in their access to forests have huge implications for the food security. The authors argue that empowering women in the forest sector can create significant development opportunities and improve food security and nutrition among rural people.

In his article, P. Dewees looks at how forests and trees can help households withstand tough times – that is, to be resilient in the face of economic and environmental hardship. He sets out some policy responses that would encourage the integration of forests and trees in agricultural systems to increase this resilience, and he advocates interventions at a landscape scale.

B. Vinceti and her co-authors discuss the concept of "sustainable diets", which are diets that conserve biodiversity, are culturally acceptable, provide adequate nutrition and optimize the use of natural and human resources. The authors find that forests and trees make substantial contributions to the nutritional quality of the diets of many rural people, and they, too, advocate the management of heterogeneous landscapes to ensure that food-production systems are nutrition-sensitive and minimize their ecological footprint.

The final article in this edition comprises the summary statement issued by organizers at the end of the International Conference on Forests for Food Security and Nutrition; it includes a number of recommendations arising from the papers presented at the conference and the ensuing discussions.

There is no doubt that forests and trees are essential components of most sustainable food-production systems, as both producers of foods and providers of ecosystem services. Achieving an optimal mix of forests and trees in landscapes, however, requires more research, development and extension, and much more interaction between the various sectors – such as forestry, agriculture, water, energy and land-use planning. By combining forces, the sectors can make best use of existing knowledge and experience, including traditional knowledge, with the ultimate goal of building an open and fair global society and thereby ensuring food security and adequate nutrition for all.

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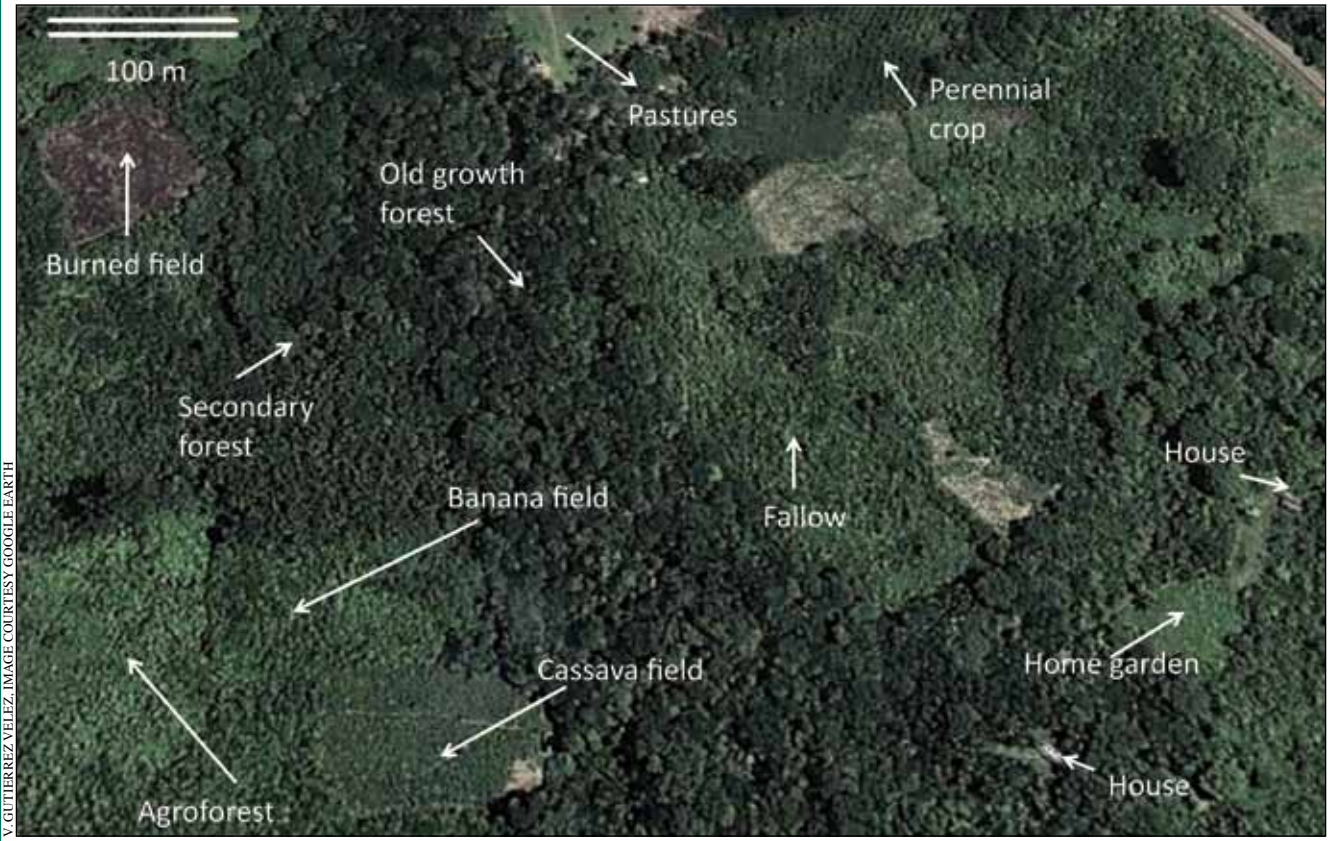



V. GUTIERREZ VELEZ, IMAGE COURTESY GOOGLE EARTH

# Managing landscapes for greater food security and improved livelihoods

*C. Padoch and T. Sunderland*

*The research and development community should focus more effort on reintegrating food production and conservation in smallholder-managed landscapes.*

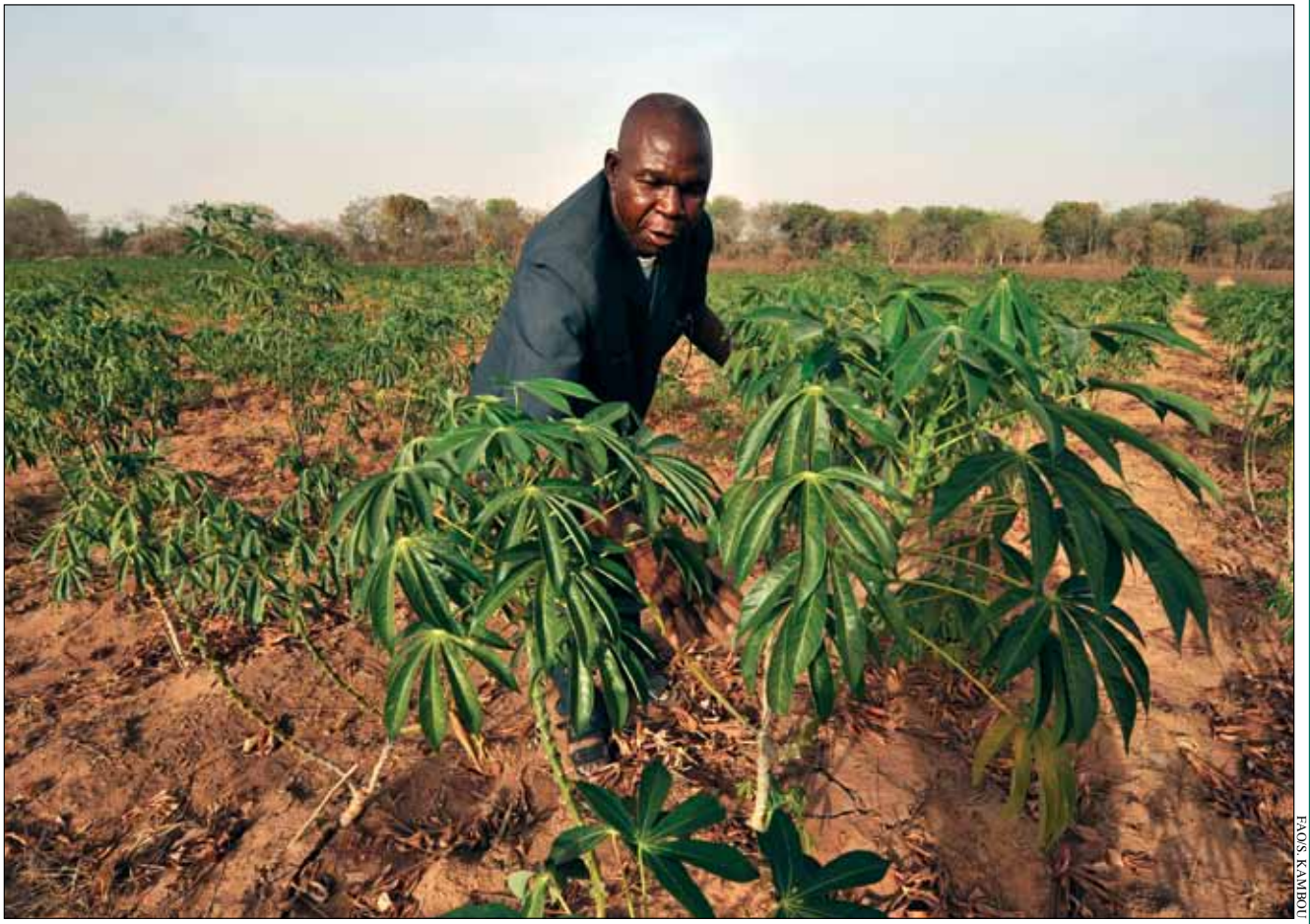
The "sustainable intensification" of agriculture is being advocated as the optimum means to advance and reconcile two pressing global issues: the need to protect ever-decreasing forest lands, and the imperative to feed the growing human population. The sustainable-intensification paradigm has come to dominate the discourse of many institutions devoted to economic and agricultural development, including the research centres of the CGIAR[1] (Pretty, 2009).

The interpretation of sustainable intensification appears to differ considerably depending on the programme, but invariably it involves the goal of producing more food without clearing new areas of natural vegetation or further degrading the environment. At first glance this goal seems laudable and compelling, yet a number of important issues arise concerning the assumptions and meaning of sustainable intensification (Rudel *et al*., 2009; Collins and Chandrasekaran, 2012). In this article

***Above: A diverse smallholder landscape in the Amazon, Brazil. Approaches that maintain or increase the diversity of land uses and land users in landscapes offer an alternative to "sustainable intensification" in achieving food security, but they need more attention from researchers***

[1] CGIAR, of which CIFOR is a member, is a global partnership aiming to unite organizations engaged in research for a food-secure future. The name CGIAR comes from the acronym for the Consultative Group on International Agricultural Research.

**Christine Padoch** and **Terry Sunderland** are at the Center for International Forestry Research (CIFOR) in Bogor, Indonesia.



FAO/S. KAMBOU

**A farmer inspects the foliage of a cassava plant in an intensive agricultural approach in Niamy, Chad. In many parts of the world, large increases in production have been achieved per unit area using a suite of modern technologies and tools, but there are doubts about a sole focus on this approach in efforts to achieve global food security**

we ask why the intensification of agricultural production – or, for that matter, any single solution – is being championed as the only pathway to meeting sustainable production goals for agriculture. And we explore an alternative paradigm that could lead to improved outcomes.

## QUESTIONS ON SUSTAINABLE INTENSIFICATION

The intensification of production is hardly a new idea; it has been an important – indeed dominant – trend in agricultural development for many decades (Tilman *et al*., 2002). Large increases in grain production per unit area have been achieved using a suite of technologies and tools, such as high-yielding planting materials, increased irrigation, and large quantities of synthetic fertilizers and pesticides – the very essence of the Green Revolution (Evenson and Gollin, 2003). The use of these technologies have greatly boosted food supplies in many – but not all – regions of the world, but it has also led to a broad range of environmental ills, such as reduced biodiversity and increased carbon and nitrogen pollution (Godfray *et al*., 2010; Collins and Chandrasekaran, 2012).

Some important questions about sustainable intensification remain to be answered. Will the same technologies and approaches employed in the previous intensification era continue to be used in "new" efforts to achieve sustainable intensification? Is it possible to deploy them in more environmentally benign and effective ways?

Doubts about an overemphasis on sustainable intensification are fuelled by empirical evidence that does not always support the seemingly logical notion that increased production per unit area will spare natural ecosystems, including forests, from further encroachment and conversion (Pinstrup-Andersen, 2013). On the contrary, more production per unit area sometimes appears to lead to more areas being cleared for production, due to lower labour inputs and greater yields and the associated increase in profitability (Angelsen and Kaimowitz, 2001; Barretto *et al*., 2013; Chappell *et al*., 2009; Perfecto and Vandermeer, 2010).

There are also questions about those regions in which intensification technologies have until now led to few benefits.

Solutions to the apparently complex and multiple reasons why the Green Revolution bypassed some of the poorest regions of, for example, sub-Saharan Africa continue to confound those who have attempted to raise yields and benefits for local producers in such areas. Producers continue to be challenged by the high costs and unreliable availability of the inputs required and the limited capacity of government extension agencies (Evensen and Gollin, 2003).

Many of the questions being asked about sustainable intensification, however, address the fundamental assumption that it is the production of more food, especially more calorie-rich grains, that should be our major focus in achieving global food security (Sayer and Cassman, 2013). Arguably, the objectives of obtaining more equitable access and distribution of what is already produced, as well as reducing waste, are equally or more important (Tscharntke *et al*., 2012). We also need to know whether the estimated 842 million people who suffered from chronic hunger in 2011–2013 (FAO, IFAD and WFP, 2013) did so mainly because of inadequate quantities of food or because they could not access the food that was actually produced (Rocha, 2007). If the problem is largely one of access to, rather than the total supply of, food, how will sustainable intensification, and a focus on production, resolve that? Moreover, the quality of food may be just as important as its quantity: in the view of many nutritionists and others, the provision of more nutritious food rather than simply more calories is the most pressing global challenge (Welch and Graham, 1999; Brinkman *et al*., 2010).

**LAND-SPARING VERSUS LAND-SHARING**

The way in which most proponents of sustainable intensification have presented their plans conforms to what has been labelled a "land-sparing" approach to reconciling production and conservation priorities, in which a greater yield is achieved on a smaller area of land, thus "sparing" the conversion of natural systems.

There are alternatives, however (e.g. Phalan *et al*., 2007), such as land-*sharing* approaches in which environmental and production functions are more closely

***Behind these huts in Song Thanh, Viet Nam, the hills show the complex mosaic landscape typically created by shifting cultivation in a land-sharing approach, with fields under active annual cropping interspersed with areas in various stages of regrowth and with older forest on the hilltops***

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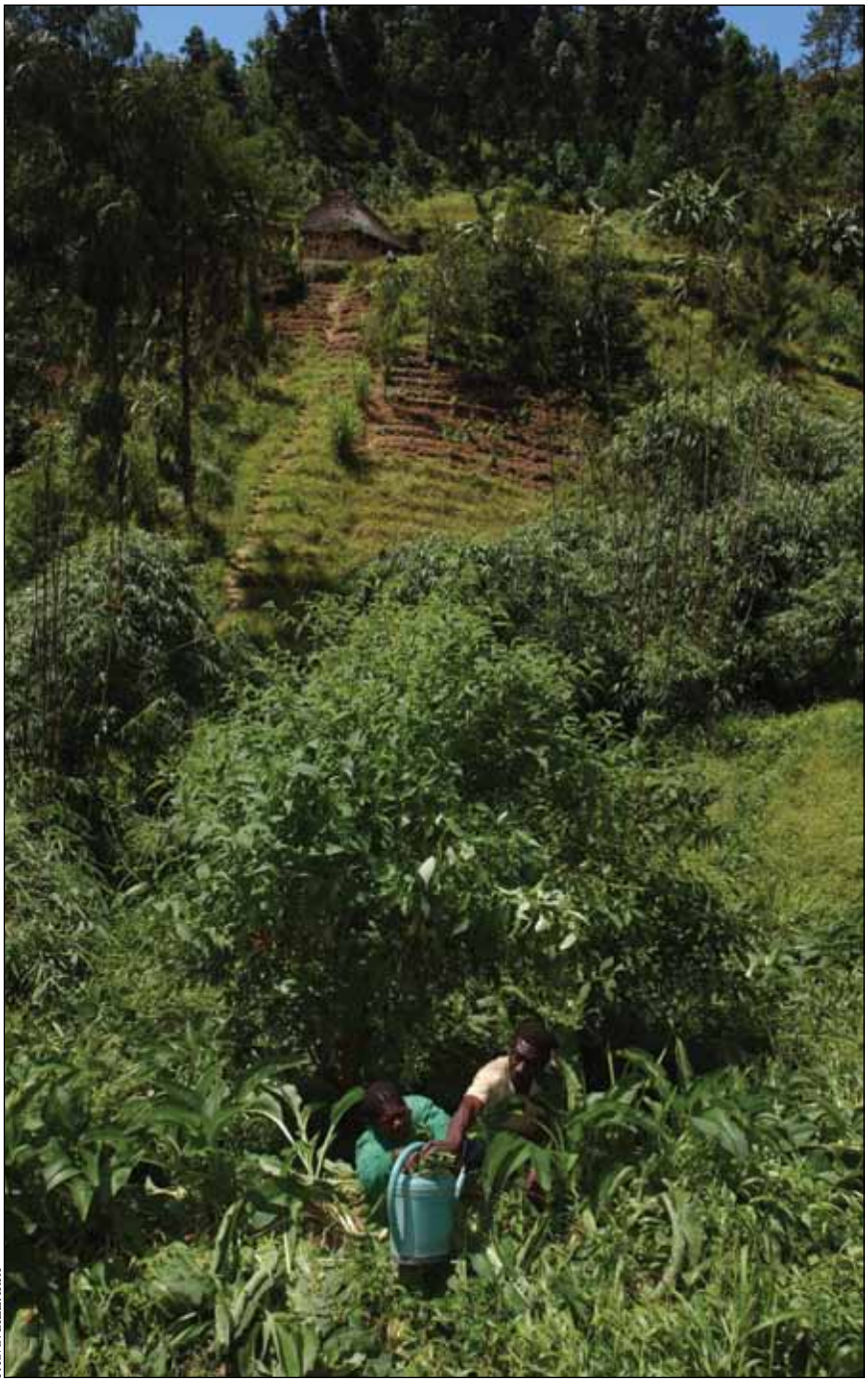
integrated at the landscape scale. Using both ecological theory and empirical data, a number of researchers have suggested that land-sharing may generate better food-production and conservation outcomes than approaches that aim to isolate and intensify both production and conservation. In addition to arguing that integrating production and conservation can improve the outcomes of both, Perfecto and Vandermeer (2010) pointed out that land-sharing often allows for a greater diversity of both land uses and land users.



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***A farmer collects leaves of the kibembeni tree to make an organic insecticide in the village of Msewe, the United Republic of Tanzania. Diverse, locally adapted production and resource management systems tend to increase the resilience of rural households***

**LANDSCAPE APPROACHES**

Landscape-scale approaches that embrace a land-sharing philosophy have recently gained traction in debates as an alternative to the more conventionally imagined sustainable-intensification pathway (Sayer *et al*., 2013). Producing food in diverse, multifunctional landscapes challenges dominant agricultural development paradigms, but it also presents issues and difficulties. For example, many types of integrated landscape approach have not been studied by scientists, and the existing research and policy framework may be insufficiently integrated to improve either agricultural production or environmental protection in such diverse landscapes (Tilman *et al*., 2011).

The lack of rigorous research is concerning and needs to be addressed. A central problem for advancing landscape approaches may be that they combine agricultural production and environmental conservation in ways that are unfamiliar to specialized scientists, who have made many of the recent advances in agronomy and conservation; the unfamiliar is rejected or, more likely, ignored (Sunderland, Ehringhaus and Campbell, 2008). But the farming of diverse landscapes has long been the dominant smallholder paradigm. There is much practical experience to build on, therefore, in both management practice and governance.

### Addressing access and diversity

Even if landscape approaches are less of a sure thing for directly increasing the global supply of familiar commodity crops, they have great potential for resolving other issues that are central to the food security of some of the world's most vulnerable people. Landscape approaches are already known by many of the people who tend to

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*A mosaic of more and less traditional land uses in a landscape in northern Thailand. Realizing the promise of integrated landscape approaches requires the willingness and ability of researchers to work across sectoral, academic and ideological boundaries*

be the targets of development programmes, especially those who have benefited little from previous initiatives. They offer promise for solving some food-related problems that have proved to be more intractable than the basic task of producing more calories – such as improving access to food and nutrition through the provision of a diversity of products, and thus improving diets (Scherr and McNeely, 2008).

**More effective in marginal lands**

Landscape approaches, especially those that are developed locally, are often more suitable for lands where previous agricultural intensification has been unsuccessful, for example on sloping lands and in other areas that are marginal for conventional approaches. The diverse production activities that such systems comprise are often well adapted to the panoply of environmental, demographic, social, political and economic changes that is sweeping across much of the less-developed world. Diverse, locally adapted production and resource management systems tend to increase the resilience of rural households in the face of such changes (Scherr and McNeely, 2008).

**Reorienting research**

Realizing the promise of integrated landscape approaches, however, requires the willingness and ability of researchers to work across difficult sectoral, academic and ideological boundaries. Working to improve existing locally developed and locally adapted production systems to increase incomes and improve nutrition rather than "reinventing" landscape approaches to fit the constructs and preconceptions of the research and development community will require a reorientation of research ideas, ideologies and priorities.

While the challenge is undoubtedly complex, making use of existing experience will help. It is estimated that 40 percent of all food in the less-developed world originates from smallholder systems, and many of these depend essentially on diverse landscapes (Godfray *et al*., 2010). Smallholder farmers worldwide and throughout history have managed landscapes for food and other livelihood needs. Forests, woodlots, parklands, swidden-fallows and other tree-dominated areas are integral parts of many smallholder landscapes and household economies (Agrawal *et al*., 2013).

Smallholder-managed landscapes are, of course, variable in spatial extent, complexity and management, among other things. One of the few generalizations that can be made about them is that they tend to be diverse, complex and dynamic, which is the main source of their strengths and also of their weaknesses (van Vliet *et al*., 2012).

**Amazonian floodplain farmers**

On the Amazonian floodplains, smallholder farmers have created heterogeneous, mosaic landscapes characterized by high levels of ecosystem and species diversity at different spatial scales (Padoch and Pinedo-Vasquez, 2000; Sears and Pinedo-Vasquez, 2004). To manage the natural variation of complex floodplain environments, farmers in these agro-ecological landscapes integrate strategies of production, use and conservation to serve multiple objectives, and they adapt their management to seasonal or even diurnal (in the estuary) fluctuations in water level. Their plots are not randomly arranged, and nor are they "primitive" or "unproductive" versions of modern or industrial-scale farm fields. Smallholder strategies of land use and resource management are often based on the concurrence of intensive and extensive activities that simultaneously minimize risk and maximize labour opportunities while allowing for adaptation to opportunities and problems as they emerge.

The adaptive management practised by Amazonian floodplain farmers results in multifunctional farming systems in which the production of a diversity of goods and services is integrated and the particulars of the system are attuned to biophysical, social and economic conditions that vary, often dramatically, over time and space. This multipurpose management is one of the characteristics that best distinguishes smallholder systems from the simplified practices of large-scale agriculture and industrial farming and forestry.

Transformations resulting from farming and other resource-use activities often lead to increased habitat diversity as well as to increased levels of connectivity and mobility within forest–field landscapes (Pinedo-Vasquez *et al*., 2001). Farmers, who simultaneously are also foresters, fishers and hunters, transform and manage these landscapes, often making them more ecologically diverse and thus providing favourable habitats for fish (Goulding, Smith and Mahar, 1995), wildlife (Bodmer and Pezo Lozano, 2001), trees (Pinedo-Vasquez *et al*., 2002) and fruit trees (Hiraoka, 1992).

The diverse patches of smallholder mosaics provide ecosystem services in ways that are poorly understood. Such services may include, for example, microclimatic effects that make agricultural production possible or more profitable in times when extremes in temperature or humidity would otherwise prevent farm production. Among the many ecosystem services that small forest stands supply to agricultural fields and the families who manage and share the space are a reliable supply of water, shade and forage for livestock; refuges, food and breeding sites for fish; and a variety of valuable forest products to support farmer families in times of climatic stress.

The effects of diverse patches on seed availability for the restoration of forest species and hence of soil fertility may often also be among the crucial but hidden benefits of diverse, smallholder-developed and -managed landscape mosaics. Typically, several of the patches in a given human-modified landscape on the Amazon floodplain will comprise highly diverse agroforests that include timber trees and other economically valuable trees and herbaceous species. There will also be multistoried and fruit-rich homegardens in and around human settlements, which are particularly valuable for food security and nutrition. Institutions and non-governmental organizations devoted to landscape approaches to agricultural development often promote agroforests and homegardens as being particularly valuable (Sayer *et al*., 2013; Scherr and McNeely, 2008).

**SHIFTING CULTIVATION**

In most discussions of successful landscape approaches, however, there is a conspicuous omission. Shifting cultivation, also known as swidden or slash-and-burn agriculture, is an integral part of many, if not most, tropical forest landscapes crucial for biodiversity conservation and watershed protection, including those in the Amazon Basin, Borneo and Central Africa (Ickowitz, 2006; Padoch *et al*. 2007; Mertz *et al*., 2009; Schmidt-Vogt *et al*., 2009). But this manner of managing forests and landscapes for food and other human needs has been criticized, condemned and in some cases criminalized (Fox *et al*., 2009; Mertz *et al*., 2009).

Few of the features of shifting cultivation seem to fit into any conventional category of sustainable production or landscape management. The cutting of trees, the burning of fields, the comparatively low production of staple crops and the apparent abandonment of fields after a year or two of cropping – all highly visible features of many such systems – are largely regarded worldwide as primitive, wasteful and destructive. Efforts to eliminate such practices have been central to many national and international conservation and development programmes (Cramb *et al*., 2009; Fox *et al*., 2009).

But beyond the smoke and the prejudices inherent in a term like "slash-and-burn", it is clear that many shifting cultivation systems could be valuable components of a landscape approach to agricultural production in forested regions. Including them would require a willingness to reject the lure of simplicity that alternative solutions offer.

Shifting cultivation is complex on several levels (van Noordwijk *et al*., 2008; Padoch *et al*., 2007). The biodiversity of some of these systems is almost legendary. When the shifting cultivation systems of the Hanunoo people of Mindoro island in the Philippines were studied more than half a century ago (Conklin, 1957), they were found to involve more than 280 types of food crop and 92 recognized

rice varieties, with several dozen of these usually showing up in any one field. More recently, research in the upland rice fields of Southeast Asian farmers has commonly identified some 30 species of staple crops, 30–40 species of vegetables and 25 species of herbs and spices (Anderson, 1993; Sutthi, 1995; Dove, 1985; Colfer, Peluso and Chung, 1997).

The above figures are only for crops in farm fields: the landscapes of the Hanunoo shifting cultivators also included extensive areas of forest of various ages and with significant levels of biodiversity (Rerkasem *et al*., 2009). Although such areas in these landscapes are commonly referred to as fallows, many are managed intensively for economic and other products, including such nutritionally valuable products as wild meat. Forest fallows also often provide ecosystem services that are less easily perceived and measured, such as pollination and the maintenance of water quality and supply. Recent research has determined that forest–field mosaics such as those of the Hanunoo often sequester high levels

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***Hillside swiddens in Nam-Et Phou Louey, northern Lao People's Democratic Republic***

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**A hillside subject to shifting cultivation in the Lao People's Democratic Republic**

of carbon, especially in the soil (Zeigler *et al*., 2012). This may surprise many researchers and policy-makers because slash-and-burn is widely condemned as a particularly environmentally damaging form of agriculture.

The greatest obstacle to including shifting cultivation in the new landscape paradigm, in the eyes of both development professionals and conservationists, is not, we suspect, the illegibility of its patchy landscapes (see below) or the complexity of its management, but its inherent dynamism. Change is what defines a system as shifting cultivation: annual crops are moved from plot to plot every year or two; and as forests regrow in one sector, they are felled in another. Can so much dynamic change be tolerated in a "sustainable" landscape? Can shifting cultivation be sustainable if it includes slashing and burning woody vegetation?

Many shifting cultivation systems worldwide have adapted successfully to larger human populations, new economic demands and the directives of anti-slash-and-burn policies and conservation prohibitions. Such adaptation has taken a large number of pathways, of which the more active management of fallows has perhaps been the most important. Examples include the management of rich mixtures of marketable fruits and fast-growing timbers in Amazonia and the production of rubber and rattans in Southeast Asia (Sears and Pinedo-Vasquez, 2004; Cairns, 2007). These adaptations suggest that the sustainability of shifting cultivation systems emerges when it is seen at broader spatial and longer temporal scales: shifting cultivation, in common with many smallholder-influenced landscapes, is constantly mutable.

## Negative impacts of replacing shifting cultivation

An important new study (Castella *et al*., 2013) analysed changes in the patterns of forest–field landscapes that occurred as environmental and socio-economic change transformed the territories of seven villages in the northern uplands of the Lao People's Democratic Republic over a period of 40 years. In this region, where a

tradition of shifting cultivation had created intricately patterned landscapes of forests, fallows and farms, such landscapes are now being radically altered by policies aimed at increasing forest cover and promoting intensive commercial farming. Shifting cultivation, with its complex landscapes, is deliberately being replaced with a land-sparing model of agriculture. This is because the segregation of land uses is perceived as most efficient for achieving multiple objectives in the context of a growing population, and shifting cultivation is widely viewed as "primitive" by government and other institutions.

Based on extensive field research, however, Castella *et al*. (2013) found that by imposing strict boundaries between agricultural and forest areas, interventions in the name of land-use planning have had significant negative impacts on the well-being of rural communities and especially on their ability to adapt to change. Farm and forest products that previously were "intricately linked at both landscape and livelihood levels, are now found in specialized places, managed by specialized households" (i.e. the domestication of non-wood forest products) and are collected by specialized traders. The authors argued that "this trend may have negative consequences for the resilience of the overall landscape as it reduces its biological and socio-economic diversity and therefore increases vulnerability to external shocks" (Castella *et al*., 2013).

Productive, complex and dynamic landscapes in the Lao People's Democratic Republic and elsewhere lend flexibility to household economies and contribute to appropriate responses to climatic and economic perturbations. Programmes of directed change, such as the one promoted by the Lao Government, attempt to create distinct zones for agricultural intensification and forest conservation. Up to now, however, they have not led to more sustainable resource management, and the simplified, intensified agro-ecological systems that have been advocated have not benefited local people.

## TRADITIONAL APPROACHES ARE A VALUABLE RESOURCE

We do not suggest that existing smallholder practices, no matter how diverse, complex and dynamic, are invariably ideal or well-adapted to rapidly changing conditions. We do suggest, however, that this potential resource of knowledge, practice and products should not be ignored.

Efforts at agricultural development and biodiversity conservation (e.g. "social forestry") have often failed to take advantage of the resource that existing patterns and practices offers. There are many reasons for this failure, including a misunderstanding of the diversity that characterizes such patterns and practices, and their dynamism. Public policies tend to be sector-oriented and unsuited to managing integrated systems. Such systems are essentially "illegible" to outsiders (Scott, 1998), and local landscape management systems are therefore often ignored, denigrated or criminalized by government actors and policies. As in the Lao People's Democratic Republic, development efforts have led to specialization that often limits the capacity of smallholders to cope with risk and uncertainty.

## Landscape research should build in traditional systems

What is urgently needed is research that builds on these traditional systems, that values what these patterns and practices provide and achieve, and that succeeds in improving them to provide the additional food, feed, shelter, income and resilience that smallholders need in a rapidly changing world and to which they have an intrinsic right. It remains to be seen whether agricultural and forest research institutions can respond successfully to this challenge. Reforms to landscape governance are also imperative to allow systems that embrace landscape complexity, dynamism and multiple objectives and engage all stakeholder groups in collectively managing diverse, multifunctional landscapes.

We echo the conclusions of Castella *et al*. (2013) in calling for "more integrative planning and design processes grounded in improved multistakeholder negotiation mechanisms to enhance landscape multifunctionality and thereby increase the capacity to respond to unforeseen change". The challenge to improve food security in the face of great global uncertainty is too big for the resource offered by traditional systems to be ignored by research institutions (Opdam *et al*., 2013), including the centres of the CGIAR. The challenge is also too complex to be met solely by following the pathway of sustainable intensification. ◆

## References


**Anderson, E.F.** 1993. *Plants and people of the Golden Triangle: ethnobotany of the hill tribes of northern Thailand*. Bangkok, Silkworm Books.

**Angelsen, A. & Kaimowitz, D.** eds. 2001. *Agricultural technologies and tropical deforestation*. Wallingford, UK, CABI Publishing.

**Agrawal, A., Cashore, B., Hardin, R., Shepherd, G., Benson, C. & Miller, D.** 2013. Economic contributions of forests. United Nations Forum on Forests background paper no. 1 (available at: www.un.org/esa/forests/pdf/session_documents/unff10/EcoContrForests.pdf).

**Barretto, A.G.O.P., Berndes, G., Sparovek, G. & Wirsenius, S.** 2013. Agricultural intensification in Brazil and its effects on land-use patterns: an analysis of the 1975–2006 period. *Global Change Biology*, 19: 1804–1815. DOI: 10.1111/gcb.12174.

**Bodmer, R.E. & Pezo Lozano, E.** 2001. Rural development and sustainable wildlife use in Peru. *Conservation Biology*, 15: 1163–1170.

**Brinkman, H.J., Pee, S., Sanogo, I., Subran, L. & Bloem, M.** 2010. High food prices and the global financial crisis have reduced access to nutritious food and worsened nutritional

status and health. *Journal of Nutrition*, 140: 1535–1615.

**Cairns, M.** ed. 2007. *Voices from the forest: integrating indigenous knowledge into sustainable upland farming*. Washington, DC, Resources for the Future.

**Castella, J-C., Lestrelin, G., Hett, C., Bourgoin, J., Fitriana, Y.R., Heinimann, A. & Pfund, J-L.** 2013. Effects of landscape segregation on livelihood vulnerability: moving from extensive shifting cultivation to rotational agriculture and natural forests in northern Laos. *Human Ecology*, 41: 63–76.

**Chappell, M.J., Vandermeer, J.H., Badgley, C. & Perfecto, I.** 2009. Wildlife-friendly farming vs. land sparing. *Frontiers in Ecology and the Environment*, 7: 183–184.

**Colfer, C.J.P., Peluso, N.L. & Chung, C.S.** 1997. *Beyond slash and burn: building on indigenous management of Borneo's tropical rain forests*. New York, USA, New York Botanical Garden.

**Collins, E.D. & Chandrasekaran, K.** 2012. *A wolf in sheep's clothing? An analysis of the 'sustainable intensification' of agriculture*. Friends of the Earth International (available at: www.foei.org/en/wolf-in-sheeps-clothing).

**Conklin, H.C.** 1957. *Hanunoo agriculture: a report on an integral system of shifting cultivation on the Philippines*. Rome, FAO.

**Cramb, R.A., Colfer, C.J.P., Dressler, W., Laungaramsri, P., Trung, L.Q., Mulyoutami, E., Peluso, N.L. & Wadley, R.L.** 2009. Swidden transformations and rural livelihoods in Southeast Asia. *Human Ecology*, 37: 323–346.

**Dove, M.R.** 1985. *Swidden agriculture in Indonesia*. Berlin, Mouton.

**Evenson, R. & Gollin, D.** 2003. Assessing the impact of the Green Revolution, 1960 to 2000. *Science*, 300(5620): 758–762.

**FAO, IFAD & WFP.** 2013. *The state of food insecurity in the world 2013. The multiple dimensions of food security*. Rome, FAO.

**Fox, J., Fujita, Y., Ngidang, D., Peluso, N.L., Potter, L., Sakuntaladewi, N., Sturgeon, J. & Thomas, D.** 2009. Policies, political-economy, and swidden, in Southeast Asia. *Human Ecology*, 37: 305–322.

**Godfray, C., Beddington, J., Crute, I., Haddad, L., Lawrence, D., Muir, J., Pretty, J., Robinson, S., Thomas, S. & Toulmin, C.** 2010. Food security: the challenge of feeding 9 billion people. *Science*, 327(5967): 812–818.

**Goulding, M., Smith, N.J.H. & Mahar, D.J.** 1995. *Floods of fortune: ecology and economy along the Amazon*. New York, USA, Columbia University Press.

**Hiraoka, M.** 1992. Caboclo resource management: a review. *In* K. Redford & C. Padoch, eds. *Conservation of neotropical forests: working from traditional resource use*. New York, USA, Columbia University Press.

**Ickowitz, A.** 2006. Shifting cultivation and deforestation in tropical Africa: critical reflections. *Development and Change*, 37: 599–626.

**Lynam, J. & Herdt, R.** 1989. Sense and sustainability: sustainability as an objective in agricultural research. *Agricultural Economics*, 3: 381–398.

**Mertz, O., Padoch, C., Fox, J., Cramb, R.A., Leisz, S., Lam, N.T. & Vien, T.D.** 2009. Swidden change in Southeast Asia: understanding causes and consequences. *Human Ecology*, 37: 259–264.

**Opdam, P., Nassauer, J.I., Wang, Z., Albert,C., Bentrup, G., Castella, J.C., McAlpine, C., Liu, J., Sheppard, S. & Swaffield, S.** 2013. Science for action at the local landscape scale. *Landscape Ecology*, 28(8): 1439–1445.

**Padoch, C. & Pinedo-Vasquez, M.** 2000. Farming above the flood in the várzea of Amapa: some preliminary results of the Projeto Várzea. *In* C. Padoch, J.M. Ayres, M. Pinedo-Vasquez & A. Henderson, eds. *Varzea: diversity, development, and conservation of Amazonia's Whitewater Floodplain*, pp. 345–354. New York, USA, New York Botanical Garden Press.

**Padoch, C., Coffey, K., Mertz, O., Leisz, S., Fox, J. & Wadley, R.L.** 2007. The demise of swidden in Southeast Asia? Local realities and regional ambiguities. *Geografisk Tidsskrift – Danish Journal of Geography*, 107: 29–41.

**Padoch, C. & Pinedo-Vasquez, M.** 2010. Saving slash-and-burn to save biodiversity. *Biotropica*, 42: 550–552.

**Perfecto, I. & Vandermeer, J.** 2010. The agroecological matrix as alternative to the land-sparing/agriculture intensification model. *Proceedings of the National Academy of Sciences USA*, 107: 5786–5791.

**Phalan, B., Onial, M., Balmford, A. & Green, R.** 2011. Reconciling food production and biodiversity conservation: land sharing and land sparing compared. *Science*, 333(6047): 1289–1291.

**Pinedo-Vasquez, M., Padoch, C., McGrath, D. & Ximenes-Ponte, T.** 2002. Biodiversity as a product of smallholder response to change in Amazonia. *In* H. Brookfield, C. Padoch, H. Parsons & M. Stocking, eds. *Cultivating biodiversity*, pp. 167–178. London, ITDG Publishing.

**Pinedo-Vasquez, M., Zarin, D., Coffey, K., Padoch, C. & Rabelo, F.** 2001. Post-boom timber production in Amazonia. *Human Ecology*, 29: 219–239.

**Pinstrup-Andersen, P.** 2013. Can agriculture meet future nutrition challenges? Special debate section. *European Journal of Development Research*, 25(1): 5–12.

**Pretty, J.** 2009. Sustainable intensification of agriculture. *Natural Resources Forum*, 21: 247–256.

**Rerkasem, K., Lawrence, D., Padoch, C., Schmidt-Vogt, D., Ziegler, A.D. & Bruun, T.B.** 2009. Consequences of swidden transitions for crop and fallow biodiversity in Southeast Asia. *Human Ecology*, 37(3): 347–360.

**Rocha, C.** 2007. Food insecurity as market failure: a contribution from economics. *Journal of Hunger & Environmental Nutrition*, 1(4): 5–22.

**Rudel, T., Schneider, L., Uriarte, M., Turner II, B., DeFries, R., Lawrence, D., Geoghegan, J., Hecht, S., Ickowitz, A., Lambin, E., Birkenholtz, T., Baptista, S. & Grau, R.** 2009. Agricultural intensification and changes in cultivated areas, 1970–2005. *Proceedings of the National Academy of Sciences*, 106(49): 20675–20680.

**Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J-L., Sheil, D., Meijaard, E., Venter, M., Boedhihartono, A.K., Day, M., Garcia, C., van Oosten, C. & Buck, L.** 2013. The landscape approach: ten

principles to apply at the nexus of agriculture, conservation and other competing land-uses. *Proceedings of the National Academy of Sciences*, 110(21): 8349–8356 (available at: www.pnas.org/content/110/21/8349.full.pdf+html).

**Sayer, J. & Cassman, K.** 2013. Agricultural innovations to protect the environment. *Proceedings of the National Academy of Sciences*, 110(21): 8345–8348 (available at: www.pnas.org/content/110/21/8345.full.pdf+html).

**Scherr, S. & McNeely, J.A.** 2008. Biodiversity conservation and agricultural sustainability: towards a new paradigm of "eco-agriculture" landscapes. *Philosophical Transactions of the Royal Society B*, 363: 477–494.

**Schmidt-Vogt, D., Leisz, S., Mertz, O., Heinimann, A., Thiha, T., Messerli, P., Epprecht, M., Cu, P.V., Vu, K.C., Hardiono, M. & Truong, D.M.** 2009. An assessment of trends in the extent of swidden in Southeast Asia. *Human Ecology*, 37: 269–280.

**Scott, J.** 1998. *Seeing like a state: how certain schemes to improve the human condition have failed*. New Haven, USA, Yale University Press.

**Sears, R.R. & Pinedo-Vasquez, M.** 2004. Axing the trees, growing the forest: smallholder timber production on the Amazon varzea. *In* D. Zarin, J. Alavalapatti, F.E. Putz & M.C. Schmink, eds. *Working forests in the American tropics: conservation through sustainable management?* pp. 258–275. New York, USA, Columbia University Press.

**Sunderland, T.C.H., Ehringhaus, C. & Campbell, B.M.** 2008. Conservation and development in tropical forest landscapes: a time to face the trade-offs? *Environmental Conservation*, 34(4): 276–279.

**Sutthi, C.** 1995. *Swidden crop germplasm in the highlands of Thailand*. Chiang Mai, Thailand, Tribal Research Institute.

**Tilman, D., Cassman, K., Matson, P., Naylor, R. & Polasky, S.** 2002. Agricultural sustainability and intensive production practices. *Nature*, 418: 671–677.

**Tscharntke, T., Clough, Y., Wanger, T., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J. & Whitbread, A.** 2012. Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation*, 151: 5351g.

**Van Vliet, N., Mertz, O., Heinimann, A., Langanke, T., Pascual, U., Schmook, B., Adams, C., Schmidt-Vogt, D., Messerli, P., Leisz, S.J., Castella, J.C., Jørgensen, L., Birch-Thomsen, T., Hett, C., Bech-Bruun, T., Ickowitz, A., Vu, K.C., Yasuyuki, K., Fox, J., Padoch, C., Dressler, W. & Ziegler, A.D.** 2012. Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: a global assessment. *Global Environmental Change*, 22: 418–429. DOI: 10.1016/j.gloenvcha.2011.10.009.

**Van Noordwijk, M., Mulyoutami, E., Sakuntaladewi, N. & Agus, F.** 2008. *Swiddens in transition: shifted perceptions on shifting cultivators in Indonesia*. Occasional Paper No. 9. Bogor, Indonesia, World Agroforestry Centre.

**Welch, R. & Graham, R.** 1999. A new paradigm for world agriculture: meeting human needs: productive, sustainable, nutritious. *Field Crops Research*, 60: 160d (available at: http://dx.doi.org/10.1016/S0378-4290(98)00129-4).

**Ziegler, A., Phelps, J., QI Yuen, J., Webb, E., Lawrence, D., Fox, J., Bruun, T., Leisz, S., Ryan, C., Dressler, W., Mertz, O., Pascual, U., Padoch, C. & Pin Koh, L.** 2012. Carbon outcomes of major land-cover transitions in SE Asia: great uncertainties and REDD+ policy implications. *Global Change Biology*, 3087–3099. ◆

# The role of ecosystems in food security

*J.C. Mohamed-Katerere and M. Smith*

FAO/I. KODIKARA

***A farmer tends a water buffalo calf in Padukka, Sri Lanka. Ecosystems provide essential services for global food security***

*Food-security policies should be "ecosystem-aware" by encouraging diversity at different scales, maintaining natural infrastructure, and ensuring social justice.*

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Agricultural production cannot be sustained without ecosystem resilience and integrity. Ecosystems are communities of plants, animals and other organisms that live, feed, reproduce and interact in an area or environment. They underpin agricultural production by, for example, protecting soil and water, helping to maintain soil fertility, and providing habitat for wild pollinators and the predators of agricultural pests. Ecosystem degradation, coupled with weak ecosystem governance (see box), compromises the ability of people to farm, access and use food effectively and, in so doing, undermines the effectiveness of food-security policies. Poor people and other vulnerable groups, including women and children and particularly those in rural areas, are most at risk from any erosion of food security.

This article examines the many roles of ecosystems in food security and argues the case for an "ecosystem-aware" approach to food-security policy-making.

## Ecosystem governance

**Ecosystem governance can be defined as the interaction of laws and other norms, institutions and processes through which a society exercises powers and responsibilities to make and implement decisions affecting ecosystem services and to distribute benefits and duties. Governance of ecosystem services emerges from the interplay of governmental, intergovernmental and non-governmental institutions, the private sector and civil society, based on rules and policies established by statutory and customary law as well as through practice.**

***Source:*** **Greiber and Schiele, 2011**

## AN ECOSYSTEM-AWARE APPROACH

An ecosystem-aware approach to food security aims not only to alleviate hunger in the short term but also to build long-term "food resilience" – defined here as the capacity of ecosystems to support food production and the ability of people to produce, harvest or buy food in the face of environmental, economic and social shocks and stresses. An example of such a shock was the 2012 drought in the United States of America, which reduced maize production and sent global prices soaring (Da Silva, 2012); another example was the 2004–05 locust invasions in the Sahel, which decimated crops and contributed to a major food crisis there (IFRC, 2005). Stresses are slower-onset changes such as increasing aridity or temperature changes, the intensification of conflicts, discrimination, a lack of access to resources, debt, and inflation. In theory, stresses are easier to respond to because they have a higher level of predictability; for poor people and developing countries, however, low levels of social and economic well-being make coping with stresses a considerable challenge.

Preparing better for shocks and stresses can help boost food production. A study of 73 countries, for example, found that those countries with more equitable initial land distribution achieved economic growth rates 2–3 times higher than those without (Deininger, 2003). FAO (2011) found that if women had the same access to productive resources as men they could increase yields on their farms by 20–30 percent and total agricultural output in developing countries by 2.5–4 percent. This would reduce the number of hungry people in the world by 12–17 percent and lift 100–150 million people out of hunger. IUCN experience in the Tacaná Volcano area in Central America shows that ecosystem restoration, greater agricultural and ecosystem diversity, and investment can boost food security (see box).

Food-security policy-makers in all countries have much to gain from integrating ecosystem management and good ecosystem governance in their policy measures and from collaborating with other sectoral policy-making initiatives to ensure that all such initiatives support food security. Effective policies will also address the social aspects of an ecosystem-aware approach to food security by strengthening land tenure, access rights to natural resources, local organizations, and gender equality.

### Ecosystem restoration, social inclusion and diversity enhance food security in the Tacaná Volcano area in Guatamala and Mexico

**In the high-altitude upper watersheds of the Suchiate River and the Coatán in Guatemala and Mexico, the IUCN Water and Nature Initiative has co-executed projects that combine the rehabilitation of ecosystems with the development of social capital through income generation. Activities such as aquaculture, honey production and agro-ecology (community gardens); reforestation and mangrove conservation; solid waste recycling and earthworm production; and septic tank initiatives have helped reduce soil erosion and the risk of flooding and increase food security. Reforestation activities, including the establishment of forest nurseries and the planting of 45 000 plants to reforest 45 hectares of land with native tree species threatened with extinction, have contributed to slope stabilization and watershed protection. To help increase household income, women and the young received training on how to start new businesses. Gender and age-dependent skills' training was vital for curbing unemployment and migration. Households have gained more access to food and higher nutrition as a result of greenhouse production, mushroom-growing, crop diversification and agroforestry, as well as the restoration of the irrigation system.**

***Source:*** **M. Smith, personal communication, 2013**

## THE FOUR DIMENSIONS OF FOOD SECURITY

Food security can be thought of as comprising four dimensions (FAO, 2008):

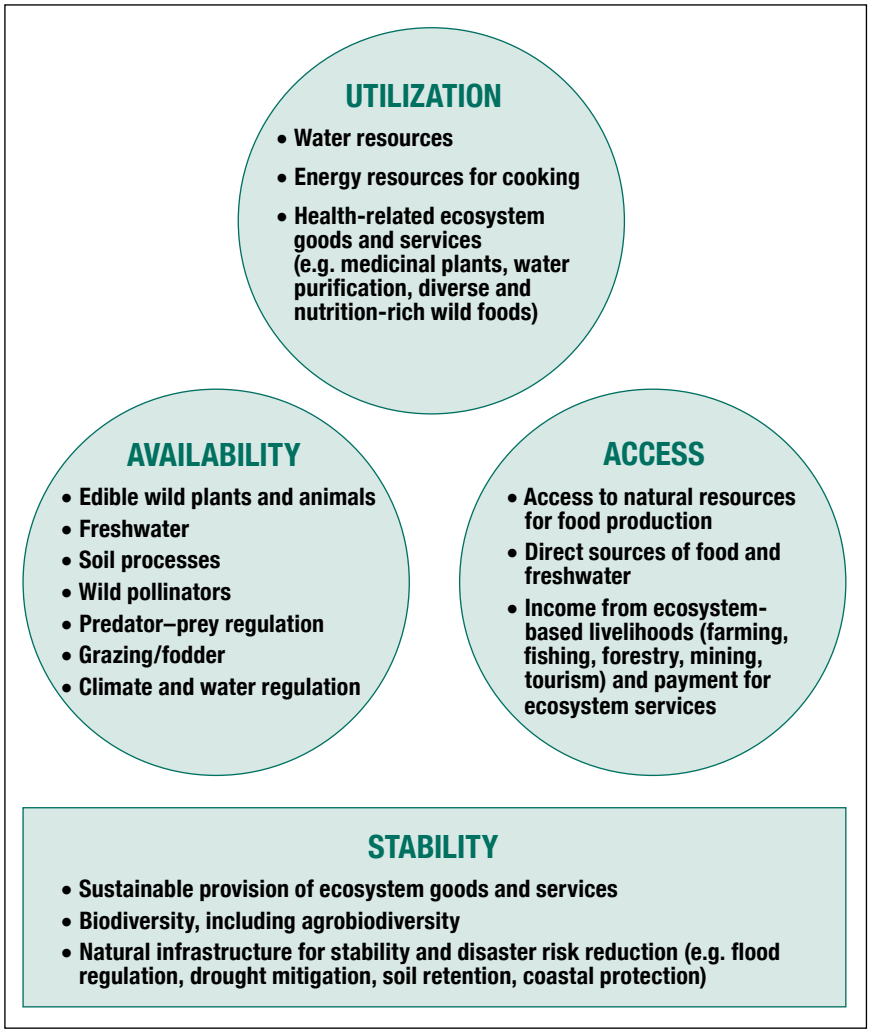
- availability – the supply of sufficient quantities of food of appropriate quality, from both natural and cultivated systems;
- access – the ability of individuals to obtain food at all times through their own production or from markets or other sources;
- utilization – the means by which individuals are able to gain energy and nutrition from food;
- stability – the availability of sufficient and adequate food that is accessible and usable on a reliable, sustainable basis.

Only when all four dimensions are fulfilled simultaneously does an individual, household, community or nation achieve food security.

## ECOSYSTEM CONTRIBUTIONS TO FOOD SECURITY

Ecosystems, including forests, contribute to all four dimensions of food security, as illustrated in Figure 1. For example:

- Forests contribute to soil processes, including the maintenance (and sometimes increase) of fertility, and reduce soil erosion, and they provide habitat for wild pollinators and the predators of agricultural pests.
- Forests provide access to food both directly (through the edible wild plants and animals found there, and as a source of genetic material for domestication) and indirectly (via forest-product income that can be used to buy food).
- Medicinal plants obtained from forests contribute to people's health, increasing the efficiency of, and benefits obtained from, food consumption.
- Mangrove and other coastal forests help protect coastal areas from


UTILIZATION
• Water resources
• Energy resources for cooking
• Health-related ecosystem goods and services (e.g. medicinal plants, water purification, diverse and nutrition-rich wild foods)
AVAILABILITY
• Edible wild plants and animals
• Freshwater
• Soil processes
• Wild pollinators
• Predator–prey regulation
• Grazing/fodder
• Climate and water regulation
ACCESS
• Access to natural resources for food production
• Direct sources of food and freshwater
• Income from ecosystem-based livelihoods (farming, fishing, forestry, mining, tourism) and payment for ecosystem services
STABILITY
• Sustainable provision of ecosystem goods and services
• Biodiversity, including agrobiodiversity
• Natural infrastructure for stability and disaster risk reduction (e.g. flood regulation, drought mitigation, soil retention, coastal protection)

*1*
***Ecosystem contributions to the four dimensions of food security***

flooding, thereby increasing the stability of food production in nearby fields and fish ponds.

## WHY SHOULD FOOD SECURITY POLICY-MAKERS WORRY ABOUT ECOSYSTEMS?

Ecosystem degradation can undermine the effectiveness and impacts of food-security policies, while inappropriate policies can damage ecosystems and their ability to support food systems. Some of the consequences of ecosystem degradation for food security are described below.

### Availability of food

Food availability depends on the productivity of both cultivated and natural systems. Globally, poor rural people are most severely affected by food insecurity, with 80 percent of these communities being food insecure (compared with 20 percent of poor urban populations), and they rely heavily on natural resources to maintain their livelihoods. About half of all food-insecure people live in smallholder farming households and roughly one-fifth are landless (Sanchez *et al*., 2005). In poor rural communities, therefore, resource degradation can make the difference between having food and going hungry. Worldwide, almost half a billion poor people are estimated to meet a significant proportion of their food needs from the harvesting of wild plants and animals (Sanchez *et al*., 2005). Ecosystem degradation and natural disasters that reduce the availability of these food sources will also have a large impact on food security.

### Access to food

Globally, about 1 billion people earn income from the use of wild natural resources (Pimentel *et al*., 1997). Marine, freshwater and forest resources are particularly important: according to FAO (2010), fisheries and aquaculture – which, in turn, often have a significant dependence on forests – support the livelihoods of 8 percent of the world's population. Many poor people rely on the sale of timber and non-timber forest products (such as wild meat, honey, medicinal plants and woodfuel) to buy food and meet other important household expenses (Sunderland, 2011). In general, ecosystem-based activities (such as agriculture, forestry, fisheries and tourism) are critically important sources of income for poor people, especially in rural areas. Threats to these income sources – from, for example, ecosystem degradation, natural disasters, conflict and the collapse of commodity prices – have severe knock-on effects on food security.

### Use of food

Rural and urban poor people in developing countries depend on natural biomass (particularly wood) for cooking and certain forms of food preservation (e.g. smoking and drying). Access to woodfuel expands the choice and range of foods that are consumed, including important protein sources such as beans and meat that require higher levels of energy for preparation. The loss of access to woodfuel through deforestation or resource-use restrictions, therefore, can affect both the quantity and quality of food. Insecure environmental conditions – caused, for example, by high winds, floods, pests and plant diseases – can reduce effective food storage.

## STABILITY OF FOOD SUPPLY

A stable food supply implies food systems that ensure sustainable food availability, access and use. It also requires that food systems are resilient to social, economic and environmental shocks and stresses. Some such shocks and stresses, and their policy implications, are outlined below.

### Unsustainable development

Economic development that appropriates resources and ecosystems and gives tighter control over them to the state or through them to private investors tends to restrict access by poor people to critical food-security assets such as forests, coasts and water resources. Infrastructure development for coastal tourism (e.g. hotels, piers and recreational facilities), for example, increases effluent discharges, disturbs coastal ecosystems such as mangrove forests, and reduces access to coastal flats that, in many countries, serve as seaweed- and mollusk-harvesting grounds for local people. Rapid urbanization can also lead to reduced access to food because the poor people in urban areas are less connected to wild foods and therefore have less potential to earn income using natural resources.

Unsustainable agricultural and industrial development is causing widespread damage to ecosystems through the pollution of land and water. UNEP (2006) reported that, globally, little or no progress had been achieved in preventing, reducing or controlling pollution of the marine environment. Fertilizer runoff, for example, damages marine and freshwater ecosystems, including coral reefs, and diminishes the availability of fish and molluscs, which are critical protein sources for many. The impact of nitrogen pollution has been particularly severe, resulting in a 50–90 percent decline in mangroves in most regions over the last four decades (UNEP, 2006). The number of coastal dead zones has increased dramatically in recent years. Of the 169 coastal dead zones worldwide, only 13 are recovering, and 415 coastal areas suffer from eutrophication (UNEP, 2006).

Around 80 percent of marine pollution is caused by land-based activities. Pollution, climate change and increased catches have contributed to an unprecedented deterioration in fish stocks in the last 20 years (Gaddis *et al*., 2012). Although catches more than quadrupled between the early 1950s and the mid-1990s, they have stabilized or diminished since then, despite increased fishing (Gaddis *et al*., 2012). Some 1 141 fish species are vulnerable to endangerment, 486 are endangered

FAO/S. TUNGSAGULGRAIT

***Children play in clean water in a forest in Thailand. Ecosystems provide clean water for downstream agriculture and for human consumption***

FAO/F.MCDOUGALL

*These trees in central Sudan have been cut by refugees from a nearby camp who were in search of wood and fodder. Conflict and other shocks and stresses make it more difficult for affected populations to produce and access food and obtain the water and energy needed for food preparation*

and 60 are extinct (FAO, 2010; IUCN Red Data List[1]). Coastal-zone degradation has resulted in increased human health risks and agricultural losses and the reduced availability of highly valued wild-harvested foods.

**Climate change**

A range of potential changes to climate, such as reduced rainfall, temperature extremes, rising sea-levels and more frequent floods and droughts, can affect food security. While the impacts of climate change on food production could be positive in some regions, overall they are likely to be detrimental to food security and nutrition. For example, it is estimated that climate change will cause a ten percent increase in the number of malnourished children worldwide by 2050, relative to a "no climate change" future (Committee on World Food Security, 2012). Climate change could also initiate spirals of ecosystem degradation, magnifying the direct impacts of climate change on food security. Extreme weather events could damage food transportation and storage infrastructure, reduce state capacity to respond to crises, increase food prices and yield fluctuations and lead to a deterioration in social cohesion, all of which are likely to increase food insecurity.

**Inequitable tenure**

Where land tenure is insecure or unclear, or where the state claims legal title, agricultural development tends to favour large-scale over smallholder production. Insecure tenure also acts as a disincentive for local land users to make long-term investments – such as tree-planting – to maintain ecosystem functions and improve food production. The possibility of the state extending its claim to resources, such as forest carbon as part of climate mitigation policies and medical plants as part of patent protection, remains a real threat to land and natural-resource security for rural communities. Tenure over water and fishery resources is commonly claimed by the state, even when indigenous and other local communities have customary rights.

A recent consequence of insecure, inequitable tenure regimes is the proliferation of foreign investments in land. This expansion – estimated to amount to up to 134 million hectares in Africa and 203 million hectares worldwide between 2000 and 2010 (Anseeuw *et al*., 2012) – reduces the availability of, and access to, both wild and farmed food for marginalized communities. Many foreign investments in land are for biofuels, minerals, timber and food exports. The rapid expansion of biofuel production is expected to contribute to an increase of up to 3 million undernourished preschool children in Africa and South Asia by 2050 (FAO, 2009).

**Conflict**

Weak ecosystem governance can heighten conflict and contribute to the primary causes of such conflict by exacerbating injustice, inequity and poverty. Conflicts over land and water are expected to increase as demand grows for these resources in the face of climate change, increasing population pressure and restrictions on access. Conflicts can have profound impacts on food security by causing institutional decline, worsening social relations and increasing violence, which tend to decrease local food production and increase its cost (Bora *et al*., 2010; Sayne, 2011; Schöninger, 2006; Teodosijević, 2003). Conflict makes it more difficult for affected populations to produce and access food and obtain the water and energy needed for food preparation. Food insecurity is often compounded by the destruction of rural infrastructure, the loss of livestock, deforestation, the widespread use of landmines, the poisoning of wells, and large-scale population movements caused by conflict.

**FOOD SECURITY POLICIES: WHAT'S MISSING?**

Development and conservation efforts contribute to food insecurity if they do not take into account the strong connections between food security and ecosystems. High levels of vulnerability to food insecurity among the poorest groups in society are generally linked to a heavy dependence

[1] www.iucnredlist.org

on natural ecosystems that are undergoing rapid degradation and change and to the ecosystem governance systems in place and how they are implemented. When either or both these factors – development and conservation on the one hand and inequitable and exclusionary ecosystem governance on the other – reduce the productivity or accessibility of, for example, wild foods, agricultural crops and water, they undermine livelihoods as well as the social relations that hold communities together. The resulting food insecurity is often accompanied by conflict within and between communities and neglect of the most vulnerable groups, including women and children.

Many food-security policies have improved in the last decade, including by increasingly acknowledging the right to adequate food and the importance of equitable and secure tenure. But the focus generally remains on agricultural productivity, trade and macroeconomic policies, while the central role played by ecosystems in food security continues to be neglected.

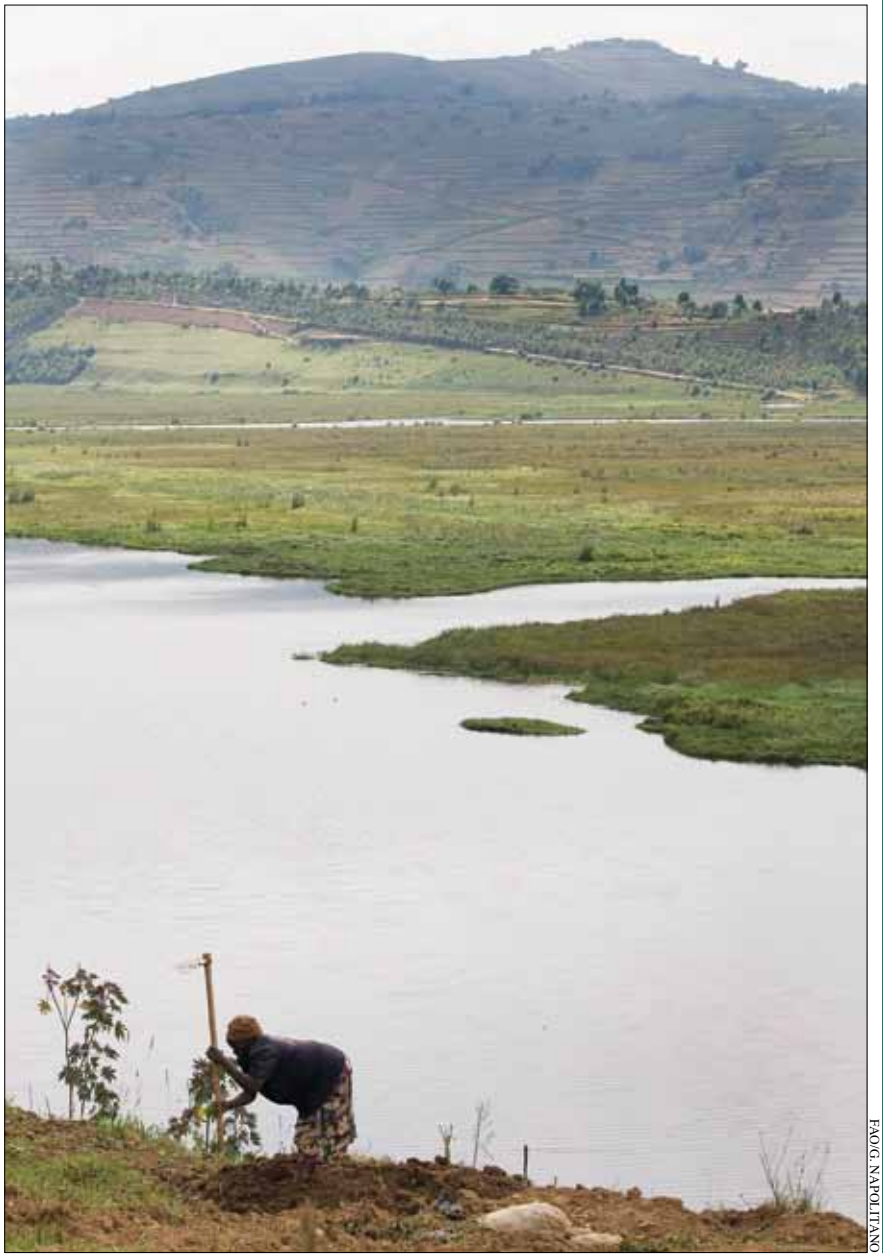
Knowledge of the importance of ecosystems to the various dimensions of food security has grown, but there continues to be insufficient investment in maintaining environmental quality, building positive social relationships around natural-resource use (institutions, organizations and learning) and developing linkages between stakeholders and sectors. The idea that there is an inevitable trade-off between agricultural productivity and ecosystem conservation is outdated, given current understanding of the dependence of agriculture on wider ecosystems and the many options for sustainably managing productive ecosystems. There is no choice but to do both – otherwise, food security will remain a pipe dream.

**Gaps in food-security policy-making**

Food-security policies and practices have a number of shortcomings, some of which are discussed below.

***Lack of a multisectoral approach.*** Food-security issues are too often dealt with in "policy silos", in which the relevant institutions (e.g. on agriculture, forestry, trade and environment) rarely collaborate to ensure that their various policies are coherent and address food security and nutrition in consistent ways. This lack of coordination between sectors leads to disconnected, sometimes contradictory policies and the neglect of intersectoral linkages and synergies (e.g. food–water–energy and food–health–nutrition).

***Lack of integration of ecosystem factors.*** Few food-security policies acknowledge the importance of maintaining and sustainably managing ecosystems, with the common result that policies are



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***A farmer works the land on the banks of Burera Lake, Rwanda. Few food-security policies acknowledge the importance of maintaining and sustainably managing ecosystems, with the common result that they lead to land degradation and therefore food insecurity***

ill-informed and ineffective and contribute to ecosystem mismanagement and degradation and therefore to food insecurity.

***Lack of participatory decision-making.*** Key actors are frequently left out of food-security decision-making; consequently, decisions do not always reflect the rights, cultures and interests of local people. Even where some degree of local participation is sought, it is often limited to men. Poor rural communities, smallholders, women and other "front-line" stakeholders are often the primary custodians of ecosystems and are usually the most affected by food insecurity. Policies that ignore their voices are unlikely to be effective.

***Commitment to climate-change action.*** There has been little sign of commitment to redress the underlying drivers of climate change and in particular the patterns of consumption and production that use energy unsustainably and generate unmanageable amounts of pollution and waste. The understanding that ecological degradation will limit opportunities to ensure food security and development opportunities is well-established in the policy and academic literature (UNEP, 2012; Rockstrom *et al*., 2009) but largely absent from policy debate about food.

***Recognition of wild resources.*** Food-security and other natural-resource-related policies still fail to acknowledge that wild resources are critical to the food security of a significant proportion of the world's poorest people. Without this recognition, such policies risk cutting off access to foods such as wild meat and fish, thereby depriving many rural people of vital sources of protein.

## HOW TO MAKE FOOD-SECURITY POLICIES MORE EFFECTIVE

### Focus on food resilience

Ecosystem-aware food-security policies aim not only to alleviate hunger in the short term but also to build long-term food resilience, which is critical if food-security objectives are to be achieved and sustained in the long term. Ecosystem-aware food-security policies strengthen both:

- the resilience of food-insecure communities to manage uncertainties and stresses such as food-price hikes and climate change;
- the resilience of ecosystems to maintain their support for the production of both wild and farmed foods in the face of shocks such as extreme weather events and stresses such as pollution.

Policy-making can best support food resilience by addressing three key issues: diversity, natural infrastructure and social justice. Each of these is described below.

### Diversity

The term diversity is used here to refer to ecosystem, biological and livelihood diversity. Diversity in the ecosystems present in a landscape and the biological resources within these ecosystems can reduce the sensitivity of local people to shocks and stresses (including price volatility) by supporting diverse livelihood and adaptive activities (e.g. agriculture and livestock farming, fisheries, forestry, tourism and hunting). Together, the various aspects of diversity can strengthen food security by reinforcing the resilience of local food systems, and policies that maintain or boost diversity will therefore support food-security objectives. For example, policies that promote diversity within a

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***A forest ranger monitors wild bird populations in the Lake Ichkeul area in Tunisia. Wetlands help clean effluent, similar to water treatment facilities***

cropping system (e.g. crop diversity, soil biodiversity and pollinator diversity) can increase the capacity of agriculture to adapt to fluctuations in growing conditions by (Boelee, Chiramba and Khaka, 2011):

- increasing water availability and thus the resilience of rural livelihoods;
- providing nitrogen-fixing capacity through the incorporation of trees and leguminous crops;
- strengthening habitat connectivity for pollinators through the incorporation of areas of natural habitat.

**Natural infrastructure**

The term natural infrastructure reflects the ability of ecosystems to deliver some of the same services that can also be provided by engineered infrastructure. For example:

- Forests help provide clean drinking water, similar to water filtration facilities.
- Mangroves help protect shorelines from storm damage, similar to sea walls.
- Natural floodplains help prevent flooding, similar to dikes and canals.
- Wetlands help clean effluent, similar to water treatment facilities.

Natural infrastructure services contribute to the food resilience of communities, for example by protecting farmland against storm surges and safeguarding communities from contaminated drinking water. To help maintain these ecosystem services, food-security policies need to be better integrated with those of other economic sectors, such as environment, forestry, fisheries, tourism and energy.

**Social justice**

Social justice embodies the ideas of good governance, economic fairness, human rights, solidarity, equality and equity. It is central to food security because it plays a large part in determining access to food within households, communities, societies and nations. Where social justice is weak, there is a high risk of food insecurity, especially among vulnerable and marginalized groups.

By addressing social justice, food-security policies can strengthen food resilience. Critically, support is required for local governance systems, particularly locally managed resource use and locally controlled production. For example, policies that strengthen the organizations of smallholder producers build local resilience by increasing the ability of farmers to set shared priorities, negotiate fair prices and make decisions on the distribution of resources necessary to increase food production.

Other areas that are critical for food security are building good social relations and tackling inequalities, including widespread discrimination against women. Policies can help remove such discrimination by formally recognizing gender equality and implementing specific policies to improve women's food security and productivity. These policies can be as simple as getting potable water into villages: it has been estimated that, in the United Republic of Tanzania (total population of 46 million people), women collectively spend 8 billion hours of unpaid work per year in water and fuel collection and food preparation, which is equivalent to the hours required for 4.6 million full-time jobs (Fontana and Natali, 2008). Other policies that improve productivity include those that secure tenure, increase knowledge, such as by specifically targeting women in agricultural extension, and improve health (FAO, 2011). Social justice cannot be ignored by food-security policy-makers. It is morally and ethically unacceptable that so many people still lack the opportunity to live free from hunger.

## WHAT DO EFFECTIVE FOOD-SECURITY POLICIES LOOK LIKE?

To be effective, food-security policies need to be ecosystem-aware and supportive of food resilience by addressing issues of diversity in multiple systems at different scales, natural infrastructure and social justice. Effective food-security policies will also adhere to the following principles.

**Effective policies recognize that the services provided by ecosystems are not limitless.** This includes the capacity of ecosystems to absorb waste. Policies should tackle land, water and air pollution to help support human and ecosystem health and wild food supplies (such as fish, fruit and wild meat). For example, municipal and industrial wastewater can be treated effectively with existing technologies, but such treatment requires strong regulatory oversight and significant infrastructure investment and capacity-building, especially in developing countries.

**Effective policies link across sectors.** Food-security policy-making needs to be based on better integration of the various economic and development sectors. In particular, the environment should be better integrated with the policies of those sectors – such as trade, energy, water, health and tourism – that affect the ecosystem services underpinning food security. Such integration will require giving environmental agencies a more central role in developing strategies for achieving food security.

**Effective policies see agricultural systems as agro-ecosystems.** Agro-ecosystems provide a wide variety of ecosystem services and are linked to other ecosystems. Taking this broader view of how agricultural systems fit within landscapes enables policies to identify and act on opportunities for synergies between crop and livestock production, fisheries and forestry to achieve food security.

**Effective policies value ecosystems as productive assets.** Food-security policies should recognize the need to maintain natural assets on the grounds that they provide important safety nets for the food-insecure and form the basis of diversified livelihoods. This recognition does not mean abandoning the total protection of particularly fragile or threatened ecosystems, but it does mean looking at protection as one tool in recovering and maintaining ecosystem services and considering interactions between protected areas, neighbouring agro-ecosystems and other sustainably managed ecosystems.

**Effective policies support increased investment in off-farm ecosystem assets.** The rationale for such policies is that off-farm ecosystem assets such as forests can strengthen the resilience of smallholder farmers and pastoralists and support diversified livelihood options, including non-agricultural income sources. This reduces the vulnerability of rural poor people to extreme weather events and price shocks. Ensuring that local people are able to use these off-farm opportunities requires financial and technical support for knowledge exchange and learning, as well as robust local organization.

**Effective policies strengthen local organization and amplify the voices of rural communities.** Local communities are often the custodians of ecosystems and the managers of food production from both wild and farmed resources and therefore are critical actors in sustaining natural resources and managing conflict over them. Supporting the inclusion of both women and men in local communities – farmers, pastoralists, forest people, shifting cultivators, fisherfolk and other food harvesters and producers – in decision-making about food security can help ensure more appropriate decisions and policies. Food-security policies need to help rural communities engage with other stakeholders in defining solutions, and they should support the recognition of the rights of rural communities to information, transparency, accountability, participation and recourse to justice. ◆

## References


**Anseeuw, W., Alden Wily, L., Cotula, L. & Taylor, M.** 2012. *Land rights and the rush for land. Findings of the Global Commercial Pressures on Land Research Project.* Rome, International Land Coalition.

**Boelee, E., Chiramba, T. & Khaka, E.** eds. 2011. *An ecosystem services approach to water and food security.* Nairobi, United Nations Environment Programme, and Colombo, International Water Management Institute.

**Bora, S., Ceccacci, I., Delgado, C. & Townsend, R.** 2010. *Food security and conflict.* Background paper for the World Development Report. Washington, DC, The World Bank.

**Committee on World Food Security.** 2012. *Food security and climate change.* High Level Panel of Experts Report 3. Rome, FAO (available at:www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE_Reports/HLPE-Report-3-Food_security_and_climate_change-June_2012.pdf).

**Da Silva, J.G.** 2012. The US must take biofuel action to prevent a food crisis. *Financial Times*, 9 August 2012 (available at: www.ft.com/intl/cms/s/0/85a36b26-e22a-11e1-b3ff-00144feab49a.html#axzz2392Moy8Z).

**Deininger, K.** 2003. *Land policies for growth and poverty reduction.* World Bank Policy Research Report. Washington, DC, The World Bank.

**FAO.** 2008. *An introduction to the basic concepts of food security.* Food Security Information for Action. Practical Guides. Rome (available at: www.fao.org/docrep/013/al936e/al936e00.pdf).

**FAO.** 2009. *How to feed the world in 2050.* Background paper for the How to Feed the World in 2050 Forum, 12–13 October 2009, Rome (available at: www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf).

**FAO.** 2010. *The state of the world's fisheries and aquaculture 2010.* Rome.

**FAO.** 2011. *The state of food and agriculture 2011: women in agriculture, closing the gender gap.* Rome.

**Fontana, M. & Natali, L.** 2008. *Gendered patterns of time use in Tanzania: public investments in infrastructure can help.* Paper prepared for the IFPRI project "Evaluating the long-term impact of gender-focused policy interventions". Cited in FAO (2011).

**Gaddis, E., Glennie, P.R., Huang, Y. & Rast, W.** 2012. Water. *In* United Nations Environment Programme, *GEO-5 global environment outlook: environment for the future we want.* Nairobi, United Nations Environment Programme.

**Greiber, T. & Schiele, S.** eds. 2011. *Governance of ecosystem services.* Gland, Switzerland, IUCN.

**IFRC.** 2005. *World disaster report 2005.* Geneva, Switzerland, International Federation of Red Cross and Red Crescent Societies.

**Pimentel, D., McNair, M., Buck, L., Pimental, M. & Kamil, J.** 1997. The value of forests to world food security. *Human Ecology*, 25: 91–120.

**Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F.S., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., De Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. & Foley, J.** 2009. Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society*, 14(2): 32 (available at: www.ecologyandsociety.org/vol14/iss2/art32/).

**Sanchez, P., Swaminathan, P.D., Dobie, P. & Yuksel, N.** 2005. *Halving hunger: it can be done.* New York, USA, Millennium Project.

**Sayne, A.** 2011. *Climate change adaptation and conflict in Nigeria. Special report.* United States Institute of Peace.

**Schöninger, I.** ed. 2006. *The challenge of hunger: global hunger index: facts, determinants, and trends.* Washington, DC, International Food Policy Research Institute.

**Sunderland, T.C.H.** 2011. Food security: why biodiversity is important. *International Forestry Review*, 13(3): 265–274.

**Teodosijevic, S.** 2003. *Armed conflicts and food security.* ESA Working Paper No. 3-11. Rome, FAO.

**UNEP.** 2006. *The state of the marine environment: trends and processes.* The Hague, United Nations Environment Programme.

**UNEP.** 2012. *GEO-5 global environment outlook: environment for the future we want.* Nairobi, United Nations Environment Programme. ◆

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# Agroforestry for food and nutritional security

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*More than 1.2 billion people already practise agroforestry, and continued adoption will improve global food security.*

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Agroforestry is a set of approaches to land management practised by more than 1.2 billion people worldwide involving the integration of trees with annual crop cultivation, livestock production and other farm activities. Agroforestry systems range from open parkland assemblages to dense imitations of tropical rainforests such as homegardens, to planted mixtures of only a few species. These systems can increase farm productivity when their various components occupy complementary niches and the associations between them are managed effectively (Steffan-Dewenter *et al*., 2007).

In this article we assess the role of agroforestry in supporting food and nutritional security. Many of the examples we present are from sub-Saharan Africa, where nine of the 20 nations with the highest burden of child undernutrition worldwide are located (Bryce *et al*., 2008). We discuss the challenges faced by agroforestry in supporting food and nutritional security, and we canvass opportunities to overcome these challenges.

***Agroforesters in Kigoma, the United Republic of Tanzania, tend crops established as part of an FAO project to strengthen forest management and its contribution to sustainable development, land use and livelihoods***

## THE BENEFITS OF AGROFORESTRY SYSTEMS FOR FOOD AND NUTRITIONAL SECURITY

### Agroforestry for food production

Solving the problem of food and nutritional security requires a range of interconnected agricultural approaches, including improvements in the productivity of staple crops, the biofortification of staple foods, and the cultivation of a wider variety of edible plants that provide fruits, nuts and vegetables for more diverse diets (Frison, Cherfas and Hodgkin, 2011). There is huge potential for the diversification of crop production in the great range of lesser-used indigenous foods found in forests and other wooded lands, which are often richer in micronutrients, fibre and protein than staple crops (Malézieux, 2013). Traditionally, such foods have been harvested in forests and woodlands, but the availability of these resources is declining due to deforestation and forest degradation (FAO, 2010), and cultivation could provide an alternative resource. The yield and quality of production can be increased through genetic improvement and on-farm management, making planting a potentially attractive option for growers. A combination of indigenous and exotic tree foods in agroforestry systems supports nutrition, the stability of production, and farmer income (Box 1).

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*A smallholder farmer harvests fruit from one of the trees he has planted near his homestead. Fruit consumption in sub-Saharan Africa is often below the recommended daily minimum, but homegardens and other agroforestry configurations can increase fruit consumption as well as income for smallholders*

**1**
**Developing domestic markets for tree foods in sub-Saharan Africa**

**Exotic and indigenous fruits cultivated and managed in agroforestry systems are important in Africa. In Kenya, for example, a 2004 survey found that over 90 percent of the more than 900 households surveyed grew fruits, with at least one-quarter growing avocado (*Persea americana*) and mango (*Mangifera indica*). Over two-thirds of households that reported fruit production harvested at least four fruit species, while over half sold some fruit.**

**Nevertheless, the average consumption of fruit and vegetables in sub-Saharan Africa is significantly lower than the minimum recommended daily intake of 400 g per person. One reason for this is that poor households that have to buy food understandably focus on the purchase of staples such as maize and rice that provide relatively cheap sources of carbohydrate to meet basic energy needs, leaving only a small fraction of the family budget to spend on other, potentially more nutritious foods. Expenditure analysis shows, however, that as incomes increase, the purchase of fruit also increases. Domestic markets for fruit are predicted to grow in sub-Saharan Africa by about 5 percent per year over the next ten years. If production and delivery to consumers can be made more efficient, the potential is high for farmers to boost their incomes by meeting this demand.**

***Source:*** **adapted from Jamnadass *et al.*, 2011**

*Maize grows under farmer-managed faidherbia natural regeneration*

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As well as directly providing edible products, trees in agroforestry systems support food production by giving shade and support to nutritious vegetable crops (Maliki *et al*., 2012; Susila *et al*., 2012). Many tree species also assist staple crops through soil-fertility improvement. This was demonstrated in an analysis of more than 90 peer-reviewed studies on the planting of nitrogen-fixing green fertilizers, including trees and shrubs, which found consistent evidence of benefits to maize yields in Africa, although the level of response varied by soil type and the technology used (Sileshi *et al*., 2008). As well as increasing average yields, the planting of trees as green fertilizers in southern Africa is able to stabilize crop production in drought years and improve the efficiency with which crops use rainwater (Sileshi *et al*., 2011; Sileshi, Debusho and Akinnifesi, 2012). This is important for food security in the context of climate change, which is increasing the incidence of drought in southern Africa.

Supporting the regeneration of natural tree and shrub vegetation in agroforestry systems can also provide significant benefits for staple crop yields. Farmer-managed natural regeneration of faidherbia (*Faidherbia albida*) and other leguminous trees in dryland agroforests (parklands) in semi-arid and subhumid Africa, for example, has been encouraged in Niger since 1985 by a policy shift that awarded tree tenure to farmers; it has led to the "re-greening" of approximately 5 million hectares (Sendzimir, Reij and Magnuszewski, 2011). Farmer-managed natural regeneration in the Sahel has led to improvements in sorghum and millet yields, and positive relationships have been observed with dietary diversity and household income (Place and Binam, 2013).

**Agroforestry for incomes to support access to food**

Market data on tree products derived from agroforestry systems are sparse, but information on export value is quantified for tree commodity crops such as palm oil (derived from oil palm, *Elaeis guineensis*), coffee (primarily from *Coffea arabica*), rubber (from *Hevea brasiliensis*), cocoa (from cacao, *Theobroma cacao*) and tea (primarily from *Camellia sinensis*). Each of these tree crops is grown to a significant extent by smallholders; in Indonesia in 2011, for example, the contribution of small farms to the country's total production area was estimated at 42 percent for palm oil, 96 percent for coffee, 85 percent for rubber, 94 percent for cocoa and 46 percent for tea (Government of Indonesia, 2013). Globally, the annual export value of these five commodities combined is tens of billions of United States dollars (FAO, 2013a) and there are opportunities to bring new tree commodities into cultivation (Box 2). Less clear is the proportion of commodity export value that accrues to smallholder cultivators, but production often constitutes a considerable proportion of farm takings and is used to support household food purchases.

There is a danger that the planting of commodities will result in the conversion of natural forest – which contains important local foods – to agricultural land, and a risk that food crops will be displaced from farmland in a trend towards

the growing of large areas of monocultural crops (e.g. oil palm; Danielsen *et al*., 2009). Monocultures also reduce resilience to shocks such as droughts, floods and, often, the outbreak of pests and diseases. In addition, buying food using the income received from a single commodity crop can lead to food insecurity for farm households when payments are one-off, delayed or unpredictable in value.

Mixed agroforestry regimes – such as shade-coffee and shade-cocoa systems – can help avoid many such negative effects by combining tree commodities in diverse production systems with locally important food trees, staple crops, vegetables and edible fungi (Jagoret, Michel-Dounias and Malézieux, 2011; Jagoret *et al*., 2012; Sustainable Cocoa Initiative, 2013) that increase or at least do not decrease commodity yields and profitability (Clough *et al*., 2009). Such systems have often been practised traditionally and are now encouraged by some international purchasers of tree commodity crops through certification and other schemes (Millard, 2011).

**Agroforestry, fuel and food**

Woodfuel, mostly comprising firewood and charcoal, is crucial for the survival and well-being of perhaps 2 billion people, enabling them to cook food to make it palatable and safe for consumption (FAO, 2008). In sub-Saharan Africa, the use of woodfuel is still increasing rapidly; the charcoal industry there was worth about US$8 billion in 2007 (World Bank, 2011). The firewood and charcoal industries are important for food and nutritional security because they produce energy and generate

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*Women sort allanblackia seeds for sale in the United Republic of Tanzania*

## 2
## Integrating markets and cultivation: the case of allanblackia

**The seeds of allanblackia (*Allanblackia* spp.), found wild in the humid forests of central, eastern and western Africa, yield an edible oil with a potential global market of more than 100 000 tonnes annually, especially as a "hardstock" for the production of healthy margarines that are low in trans-fats. A private–public partnership known as Novella Africa is developing a sustainable allanblackia oil business that could be worth hundreds of millions of United States dollars annually to local farmers. Supply chains for seed have been established in Ghana, Nigeria and the United Republic of Tanzania based on harvesting by local communities in natural forests and from trees remaining in farmland after forest clearance. Volumes are currently small (in the hundreds of tonnes) and oil is being exported for food product development. At the same time, more allanblackia trees are being brought into cultivation by improving seed-handling, developing vegetative propagation methods and selecting superior genotypes. Tens of thousands of seedlings and clones have been distributed to smallholders. The integration of allanblackia into small-scale cocoa farms is being promoted to support more biodiverse and resilient agricultural landscapes. As allanblackia trees grow, cocoa trees provide the shade they need; when they have grown, they in turn will act as shade for cocoa. Cocoa and allanblackia provide harvests at different times of the year, and when the allanblackia trees have matured they will help diversify farmer incomes and distribute them throughout the year.**

***Source:*** **adapted from Jamnadass *et al*., 2010**

income; their importance is likely to remain high for some time, despite efforts to promote "more modern" energy sources.

In poor households, firewood and charcoal are often burnt in open fires or on poorly functioning stoves, with substantial emissions of pollutants that damage human health and may lead to the premature deaths of more than 1 million people annually worldwide, the majority of them women (Bailis, Ezzati and Kammen, 2005; see article by Stoukal *et al*. in this edition). Fuel quality depends on the tree species being burnt; poor families may be forced to use species that were traditionally avoided because of their harmful smoke or that were maintained for other products, such as fruit (Brouwer, Hoorweg and van Liere, 1997).

Reduced access and increased prices have led to initiatives to promote the cultivation of woodfuel-producing tree species in agroforestry systems. Where agroforestry is practised by smallholders, less woodfuel needs to be purchased by them, there is less reliance on collecting from natural stands, and less time is involved in collection. This leaves more time for income-generating activities, especially for women, who are usually the major firewood collectors (Thorlakson and Neufeldt, 2012). Access to cooking-fuel provides people with more flexibility in what they eat, including foods with better nutritional profiles that require more energy to cook. The cultivation of woodlots allows the production of wood that is less harmful when burnt and has higher energy content.

### Agroforestry, ecosystem services, climate change and food

Trees in agroforestry systems provide important ecosystem services, including soil, spring, stream and watershed protection, animal and plant biodiversity conservation, and carbon sequestration and storage, all of which ultimately improve food and nutritional security (Garrity, 2004). Individual farmers can be encouraged to preserve and reinforce these functions – which extend beyond their farms – by payments for ecosystem services (Roshetko, Lasco and Delos Angeles, 2007).

Appropriate combinations of crops, animals and trees in agroforestry systems can not only increase farm yields, they can promote ecological and social resilience to change because the various components of such systems, and the interactions between them, will respond in differing ways to disturbances (Steffan-Dewenter *et al*., 2007). A diversity of species and functions within integrated production systems is therefore a risk-reduction strategy, and agroforestry can make important contributions to both adaptation to, and the mitigation of, climate change (Thorlakson and Neufeldt, 2012).

## CHALLENGES FOR AGROFORESTRY IN SUPPORTING FOOD AND NUTRITIONAL SECURITY

### Policy constraints

Place *et al*. (2012) identified three key policy areas in which constraints need to be overcome for agroforestry to play a greater role in food and nutritional security. First, farmers need secure land and tree tenure. Where these are absent or contested, farmer involvement in tree-planting and management can be limited, but when they are assured, greater interest in agroforestry is stimulated. Land-tenure rights are particularly important for agroforestry compared with other agricultural practices because of the relatively long period that may be required to realize benefits from managing and cultivating trees.

Second, policies that determine how farmers obtain seeds, seedlings and clones of a wide range of tree species suitable for their various purposes are crucial (Lillesø *et al*., 2011). Current policies often slow the adoption of agroforestry: for example, providing extension services with funds to give free seeds to farmers discriminates against small-scale entrepreneurial seed and seedling suppliers (as well as reducing the perceived importance to growers of the seeds). Although well-intentioned (e.g. to protect intellectual property and stop the introduction of potentially invasive species), laws to control germplasm flows internationally have also slowed smallholder access to appropriate planting material by, for example, limiting the transfer to Africa of superior cultivars of fruit trees developed in other countries, in this case notably in Asia.

Third, many policy environments do not recognize agroforestry as an attractive investment in agriculture. For example, governments often subsidize the provision of artificial fertilizers to increase staple crop yields, which discourages the adoption of improved tree-based fallow technologies that could ultimately increase crop production more cost-effectively and sustainably. Another problem is the lack of attention given to tree products and services in data collection on farmer livelihoods and therefore the lack of properly quantified information on the value of trees grown in agroforestry systems in supporting food and nutritional security (FAO, 2013b).

### Constraints in delivering tree products to markets

For many tree products, markets are poorly structured and lack coordination (Roshetko *et al*., 2007). This results in low and unstable returns to farmers and high prices for buyers of tree foods, which limits access and consumption. Problems often cited by producers include the absence of a collective bargaining system, poor transport infrastructure, and the involvement of multiple intermediaries in the supply chain, all of which act to reduce farm prices. For perishable goods such as fruit, such barriers also lead to high wastage along the supply chain and a failure to meet quality grades. Prevailing low returns mean that farmers struggle to afford inputs to improve their suboptimal farm management practices. Traders also face many problems, such as poor roads, corrupt officials and the high cost of collecting from geographically scattered producers (Jamnadass *et al*., 2011).

There has been underinvestment in the characterization of tree foods and the development of new tree cultivars that

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***Fruits of safou (*Dacryodes edulis*), a species undergoing participatory domestication in Cameroon, show some of the genetic variation that can be exploited to improve production***

have high yields and provide high-quality products under smallholder production conditions. Until recently, for example, scientists largely ignored the great potential for the genetic improvement of indigenous fruit trees (Jamnadass *et al*., 2011). Insufficient work is being done to bring these indigenous species into cultivation in the tropics.

## RECOMMENDATIONS

To strengthen the important and potentially crucial role of agroforestry in food and nutritional security, we recommend the following:

- Better quantification of the role of the products and services from trees grown in agroforestry systems in supporting the food and nutritional security of the rural poor, to allow more appropriate targeting of intervention options. Where possible, quantification should be done separately for men, women and children, small-scale farmers, the landless poor and local traders.
- Specific policies for the development of agroforestry, including more attention to ensuring smallholder tenure of trees and land, greater support for how farmers obtain tree-planting material, and wider acknowledgement of agroforestry as an agricultural investment option.
- Intensified research into tree domestication to provide planting material appropriate for smallholders, and further assessment of the complementarity and resilience of agroforestry systems in the face of climate change and other agricultural production challenges.

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## References

**Bailis, R., Ezzati, M. & Kammen, D.M.** 2005. Mortality and greenhouse gas impacts of biomass and petroleum energy future in Africa. *Science*, 308: 98–103.

**Brouwer, I.D., Hoorweg, J.C. & van Liere, M.J.** 1997. When households run out of fuel: responses of rural households to decreasing fuelwood availability, Ntcheu District, Malawi. *World Development*, 25: 255–266.

**Bryce, J., Coitinho, D., Darnton-Hill, I., Pelletier, D. & Pinstrup-Andersen, P.** 2008. Maternal and child under-nutrition: effective action at national level. *The Lancet*, 371: 510–526.

**Clough, Y., Barkmann, J., Juhrbandt, J., Kessler, M., Wanger, T.C., Anshary, A., Buchori, D., Cicuzza, D., Darrasi, K., Dwi Putrak, D., Erasmil, S., Pitopang, R., Schmidt, C., Schulze, C.H., Seidel, D., Steffan-Danielsen, F., Beukema, H., Burgess, N.D., Parish, F., Brühl, C.A., Donald, P.F., Murdiyarso, D., Phalan, B., Reijnders, L., Struebig, M. & Fitzherbert, E.B.** 2009. Biofuel plantations on forested lands: double jeopardy for biodiversity and climate. *Conservation Biology*, 23: 348–358.

**Dewenter, I., Stenchly, K., Vidal, S., Weist, M., Wielgoss, A.C. & Tscharntke, T.** 2011. Combining high biodiversity with high yields in tropical agroforests. *Proceedings of the National Academy of Sciences of the USA*, 108: 8311–8316.

**FAO.** 2008. *The state of food and agriculture. Biofuels: prospects, risks and opportunities*. Rome.

**FAO.** 2010. *Global forest resources assessment 2010*. FAO Forestry Paper No. 163. Rome.

**FAO.** 2013a. FAOSTAT. Website (available at: faostat.fao.org).

**FAO.** 2013b. Advancing agroforestry on the policy agenda: a guide for decision-makers. Agroforestry Working Paper No.1. Rome.

**Frison, E.A., Cherfas, J. & Hodgkin, T.** 2011. Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security. *Sustainability*, 3: 238–253.

**Garrity, D.P.** 2004. Agroforestry and the achievement of the Millennium Development Goals. *Agroforestry Systems*, 61: 5–17.

**Government of Indonesia.** 2013. Website (available at: http://ditjenbun.deptan.go.id/cigraph/index.php/viewstat/komoditiutama).

**Jagoret, P., Michel-Dounias, I. & Malézieux, E.** 2011. Long-term dynamics of cocoa agroforests: a case study in central Cameroon. *Agroforestry Systems*, 81: 267–278.

**Jagoret, P., Michel-Dounias, I., Snoeck, D., Todem Ngnogué, H. & Malézieux, E.** 2012. Afforestation of savannah with cocoa agroforestry systems: a small-farm innovation in central Cameroon. *Agroforestry Systems,* 86: 493–504.

**Jamnadass, R., Dawson, I.K., Anegbeh, P., Asaah, E., Atangana, A., Cordeiro, N., Hendrickx, H., Henneh, S., Ac Kadu, C., Kattah, C., Misbah, M., Muchugi, A., Munjuga, M., Mwaura, L., Ndangalasi, H.J., Sirito Njau, C., Kofi Nyame, S., Ofori, D., Peprah, T., Russell, J., Rutatina, F., Sawe, C., Schmidt, L., Tchoundjeu, Z. & Simons, T.** 2010. *Allanblackia*, a new tree crop in Africa for the global food industry: market development, smallholder cultivation and biodiversity management. *Forests, Trees and Livelihoods*, 19: 251–268.

**Jamnadass, R.H., Dawson, I.K., Franzel, S., Leakey, R.R.B., Mithöfer, D., Akinnifesi, F.K. & Tchoundjeu, Z.** 2011. Improving livelihoods and nutrition in sub-Saharan Africa through the promotion of indigenous and exotic fruit production in smallholders' agroforestry systems: a review. *International Forest Review*, 13: 338–354.

**Lillesø, J-P.B., Graudal, L., Moestrup, S., Kjær, E.D., Kindt, R., Mbora, A., Dawson, I., Muriuki, J., Ræbild, A. & Jamnadass, R.** 2011. Innovation in input supply systems in smallholder agroforestry: seed sources, supply chains and support systems. *Agroforestry Systems*, 83: 347–359.

**Malézieux, E.** 2013. Editorial. Underutilized fruit trees in Africa. Special issue. *Revue Fruits* (in press).

**Maliki, R., Cornet, D., Floquet, A. & Sinsin, B.** 2012. Agronomic and economic performance of yam-based systems with shrubby and herbaceous legumes adapted by smallholders. *Outlook on Agriculture*, 41: 171–178.

**Millard, E.** 2011. Incorporating agroforestry approaches into commodity value chains. *Environmental Management*, 48: 365–377.

**Place, F., Ajayi, O.C., Torquebiau, E., Detlefsen, G., Gauthier, M. & Buttoud, G.** 2012. Improved policies for facilitating the adoption of agroforestry. *In* M. Kaonga, ed. *Agroforestry for biodiversity and ecosystem services: science and practice*, pp. 113–128. Rijeka, Croatia, InTech.

**Place, F. & Binam, J.N.** 2013. *Economic impacts of farmer managed natural regeneration in the Sahel*. End of project technical report for the Free University Amsterdam and IFAD. Nairobi, World Agroforestry Centre.

**Roshetko, J.M., Lasco, R.D. & Delos Angeles, M.S.** 2007. Smallholder agroforestry systems for carbon storage. *Mitigation and Adaptation Strategies for Global Change*, 12: 219–242.

**Roshetko, J.M., Nugraha, E., Tukan, J.C.M., Manurung, G., Fay, C. & van Noordwijk, M.** 2007. Agroforestry for livelihood enhancement and enterprise development. *In* S. Djoeroemana, B. Myers, J. Russell-Smith, M. Blyth & I.E.T. Salean, eds. *Integrated rural development in East Nusa Tenggara, Indonesia. Proceedings of a workshop to identify sustainable rural livelihoods, Kupang, Indonesia, 5 to 7 April 2006*, pp. 137–148. ACIAR Proceedings No. 126. Canberra, Australian Centre for International Agricultural Research.

**Sendzimir, J., Reij, C.P. & Magnuszewski, P.** 2011. Rebuilding resilience in the Sahel: regreening in the Maradi and Zinder regions of Niger. *Ecology and Society*, 16 (online) (available at: www.ecologyandsociety.org/vol16/iss3/art1/).

**Sileshi, G.W., Akinnifesi, F.K., Ajayi, O.C. & Muys, B.** 2011. Integration of legume trees in maize-based cropping systems improves rain-use efficiency and yield stability under rain-fed agriculture. *Agricultural Water Management*, 98: 1364–1372.

**Sileshi, G.W., Debusho, L.K. & Akinnifesi, F.K.** 2012. Can integration of legume trees increase yield stability in rainfed maize cropping systems in Southern Africa? *Agronomy Journal*, 104: 1392–1398.

**Sileshi, G., Akinnifesi, F.K., Ajayi, O.C. & Place, F.** 2008. Meta-analysis of maize yield response to planted fallow and green manure legumes in sub-Saharan Africa. *Plant and Soil*, 307: 1–19.

**Steffan-Dewenter, I., Kessler, M., Barkmann, J., Bos, M.M., Buchori, D., Erasmi, S., Faust, H., Gerold, G., Glenk, K., Gradstein, S.R., Guhardja, E., Harteveld, M., Hertel, D., Höhn, P., Kappas, M., Köhler, S., Leuschner, C., Maertens, M., Marggraf, R., Migge-Kleian, S., Mogea, J., Pitopang, R., Schaefer, M., Schwarze, S., Sporn, S.G., Steingrebe, A., Tjitrosoedirdjo, S., Tjitrosoemito, S., Twele, A., Weber, R., Woltmann, L., Zeller, M. & Tscharntke, T.** 2007. Tradeoffs between income, biodiversity, and ecosystem functioning during tropical rainforest conversion and agroforestry intensification. *Proceedings of the National Academy of Sciences of the USA*, 104: 4973–4978.

**Stloukal, L., Holding, C., Kaaria, S., Guarascio, F. & Gunewardena, N.** 2013. Forests, food security and gender. *Unasylva*, 241: 37–45.

**Susila, A.D., Purwoko, B.S., Roshetko, J.M., Palada, M.C., Kartika, J.G., Dahlia, L., Wijaya, K., Rahmanulloh, A., Mahmud, R., Koesoemaningtyas, T., Puspitawati, H., Prasetyo, T., Budidarsono, S., Kurniawan, I., Reyes, M., Suthumchai, W., Kunta, K. & Sombatpanit, S.** eds. 2012. *Vegetable–agroforestry systems in Indonesia*. Bangkok, World Association of Soil and Water Conservation and Nairobi, World Agroforestry Centre.

**Sustainable Cocoa Initiative.** 2013. Website (available at: http://cocoasustainability.com/).

**Thorlakson, T. & Neufeldt, H.** 2012. Reducing subsistence farmers' vulnerability to climate change: evaluating the potential contributions of agroforestry in western Kenya. *Agriculture & Food Security*, 1: 15 (online) (available at: www.agricultureandfoodsecurity.com/content/1/1/15).

**World Bank.** 2011. *Wood-based biomass energy development for sub-Saharan Africa: issues and approaches*. Washington, DC. ◆

# Urbanization and forest foods in Benin

*A. Bertrand, G.A. Agbahungba and S. Fandohan*

*Urbanization is driving demand for forest foods, but a stronger regulatory environment is needed if this growing sector is to be sustainable.*

The contribution of forests to the gross domestic products of "non-forest" West African countries such as Benin is usually considered to be very low, but this notion does not hold up to scrutiny. Many plant and animal forest products are used as foodstuffs in Benin – but they often do not appear in national accounts because they are harvested and traded informally, either illegal or semi-illegally.

Worldwide, the urban population is expected to grow by over 3 billion people to 2050, primarily in less-developed countries, with the result that over 70 percent of the world's population will be living in cities by the middle of the century (United Nations Population Division, 2008). An urbanization process is under way in Benin. This article reviews the implications of that process for Benin's forest sector and especially for the role of forests in the provision of food.

## RAPID URBAN DEVELOPMENT IN WEST AFRICA

Figure 1 shows that, worldwide, the urbanization process is most dramatic in less-developed countries. Sub-Saharan Africa has a large rural population and an emerging trend of urbanization. Figure 2 shows the proportions of the total populations

***A man displays the skin of an African rock python* (Python sebae) *on a rural road in Benin. Snake – caught wild or bred in captivity – is becoming a popular food in urbanizing Benin***

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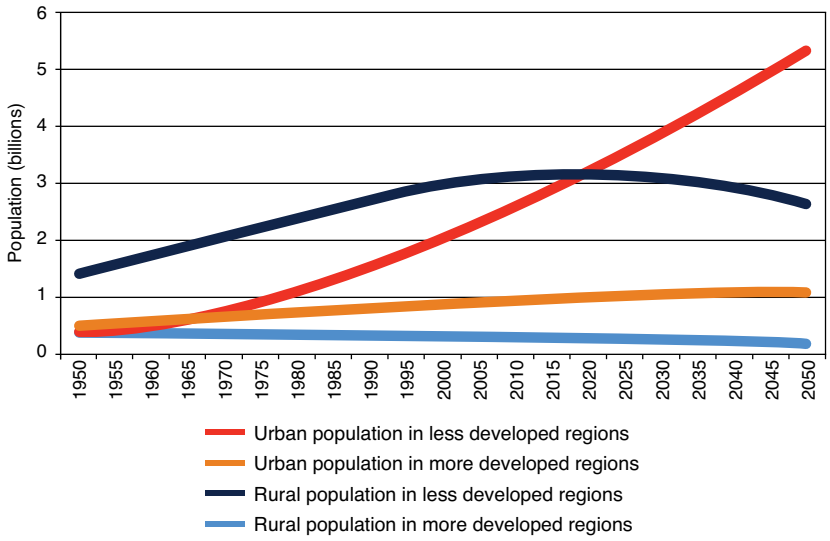
*1*
***Urban and rural population growth in developed and less-developed countries, 1950–2050***




*Source*: United Nations Population Division, 2008

in Francophone African countries that are urban. Almost half (45 percent) of Benin's population is urbanized, although Cotonou (the country's largest city) ranks only sixteenth in size among West Africa's urban areas. The trend of rapid urbanization is also strong in many of Benin's neighbours, including Nigeria, where about 50 percent of the country's 175 million people (Government of United States of America, 2013) is urbanized.

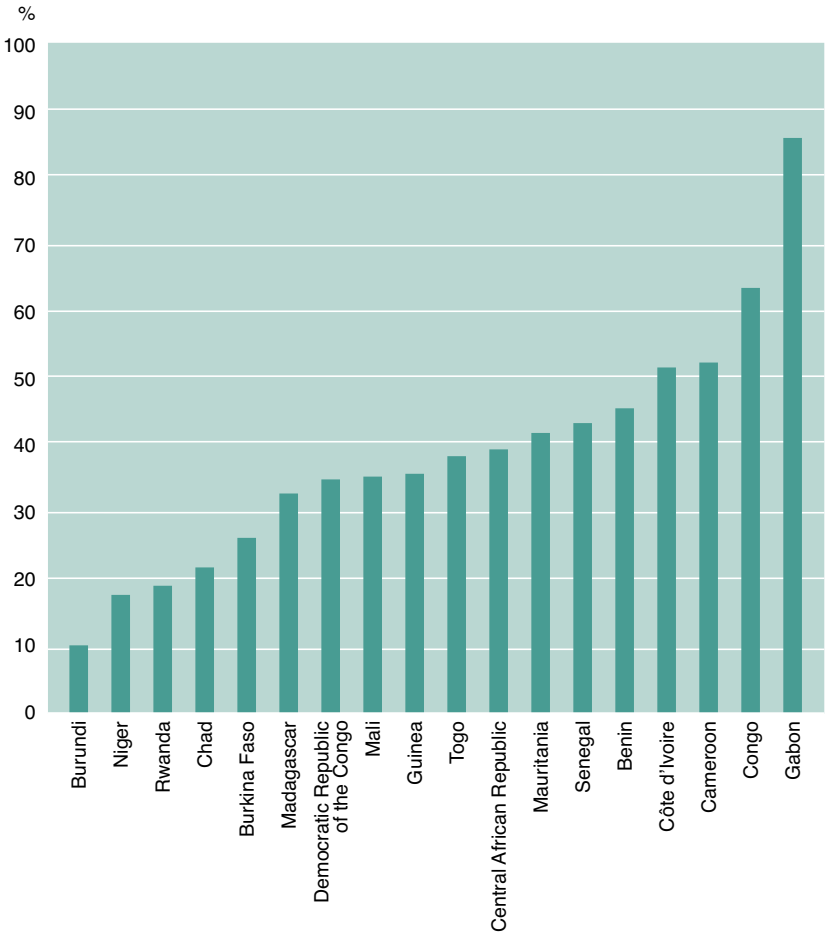
## EFFECTS OF URBANIZATION ON FORESTS

Urbanization implies a shift in lifestyles and diet patterns, and food acquisition becomes a matter of monetary economics. In the rural areas of Benin, however, on-farm consumption and subsistence farming still prevail. By creating market demand, urbanization can revitalize the production and distribution of forest food products. It can also lead to social diversification as new citydwellers act as distributors and consumers of these products.

An influx of urban consumers creates new markets that can be exploited by dynamic rural producers, enabling them to diversify their production and meet the demand for multiple and increasingly processed forest products. Rural entrepreneurs have opportunities to market new products and activities that may previously have been restricted to their family circles (Codjia, Assogbadjo and Mensah Ekué, 2003). Table 1 shows that, in 2008 (the latest year for which such data are available), a range of forest products were economically significant in Benin.

Some forest products that were once secondary, such as cashew and shea, have become major agricultural products for export (Gnimadi, 2008). Supply chains with no legal status, such as those supplying small bushmeat, are now common and can no longer be ignored.

*2*
***Percentage urban of total population, countries of Francophone Africa***




*Source*: Government of United States of America, 2013

**TABLE 1. Contribution of forests and trees to GDP in Benin, 2008**

| Product | Notes | Estimated total annual value added (million FCFA) |
|---|---|---|
| Cashew (*Anacardium occidentale*) | Export | 53 000 |
| Bushmeat (various species) | | 28 000 |
| Woodfuel | Charcoal | 27 886 |
| Breadfruit (*Artocarpus altilis*) | | 12 430 |
| Shea (*Vitellaria paradoxa*) | Butter consumed in Benin | 6 466 |
| Timber (natural forests) | | 2 923 |
| Timber (teak, *Tectona grandis*) | Export | 2 753 |
| Shea | Almonds for export | 2 237 |
| Woodcraft | | 1 898 |
| Woodfuel | Firewood | 1 517 |
| Toothbrushes | | 1 404 |
| Honey | | 1 281 |
| Cashew | National consumption | 980 |
| Néré (*Parkia biglobosa*) | | 361 |
| Palmyra palm (*Borassus* spp.) | | 293 |
| Live reptiles | | 127 |
| Medicinal plants | | 109 |
| Non-conventional farming | | 86 |
| *Irvingia* spp. | Fruit | 54 |
| Mushrooms | | 43 |
| Timber (teak) | National consumption | 31 |
| Snails (*Achatina achatina*) | | 23 |
| Baobab (*Adansonia digitata*) | | 21 |
| *Irvingia* spp. | Almonds | 21 |
| Service wood | | 15 |
| Shea | Butter for export | 8 |
| **Total forestry/trees on farms** | | **143 967** |
| **GDP Benin, 2003–2005** | | **2 169 000** |
| **Share of forestry in GDP (approx.)** | | **6.6%** |

*Source:* Bertrand, Agbahungba and Tonou, 2009

**TABLE 2. Relative share of forest subsectors in GDP, Benin, 2008**

| Forest product group | Forest product | Annual value added (million FCFA) | Percentage of total forest sector |
|---|---|---|---|
| Woodfuel | Firewood, charcoal | 29 403 | 20 |
| Plant forest products used as food in Benin | Breadfruit, shea, honey, cashew, néré, palmyra palm, *Irvingia* spp. (fruit and almonds), mushrooms, baobab fruit | 21 950 | 15 |
| Animal forest products used as food | Bushmeat, snails, non-conventional farming (agoutis, reptiles, etc.) | 28 109 | 19 |
| Export products | Cashew, teakwood, shea (almonds and butter) | 58 124 | 40 |
| Wood products for use in Benin | Timber (natural forests, teak), service wood, craftwood | 4 867 | 3 |
| Forest health products | Medicinal plants, toothbrushes | 1 513 | 1 |
| **Total, forest sector** | | **143 966** | **100*** |

*Source:* Bertrand, Agbahungba and Tonou, 2009 * Does not tally to 100 due to rounding.

This is a major issue in forest policy. Also significant is woodfuel, a forest product that is used daily in most Benin households.

Table 2 shows that, combined, plant and animal forest and tree products used as food account for almost 35 percent of the forest sector's value added, second only to exported forest products and considerably more than woodfuel. The income derived from plant and animal forest products used for food represents over 54 percent of income generated in rural areas by Benin's forest sector.

This finding confirms the major part played by forests in people's food security (Kadevi, 2001). Forests should no longer be considered primarily for their wood-producing functions (woodfuel, timber and service wood), but also for their essential contributions to feeding communities, particularly disadvantaged groups (Lebel, 2003). Such recognition will require a profound shift in forest policy. Forest food products and supply chains can add to forest productivity without diminishing existing subsectors of the forest industry dealing with wood and wood products (Assogba, 2007).

### REVENUES STAY WITHIN THE RURAL CONTEXT

Plant food products account for about half of rural forest incomes, followed by woodfuel and animal food products. Rural people constantly seek alternative sources of revenue to complement their income from farming and livestock, and these alternatives often vary according to the comparative advantages of particular areas (and thus certain activities may become locally widespread). A little over one-third of revenues derived from forest products are retained in rural areas.

## Development of forest product chains

Urban sprawl induces major social and economic changes in and around cities throughout the hinterland. In Benin, Cotonou's hinterland extends across the entire national territory and beyond the national borders into the Niger, Nigeria and Togo.

Forest-food supply chains are developed in both formal and informal – including illegal – ways (Igué, 1983). Those based on on-farm

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*A man sets out baobab fruit for sale on a roadside in Benin. With increasing urbanization, new enterprises are helping to promote the remarkable nutritional benefits of this food*

consumption (e.g. fruit such as *Irvingia* spp. and *Saba senegalensis*), conventional rural trade (e.g. "miritchi" or palmyra palm sprouts – Gschladt, 1972), traditional medicinal plants and snail-breeding are informal. Given their informality, obtaining economic data on them, such as the volume and value of outputs and the size of the workforce, is difficult, and it is especially challenging in the case of illegal value chains.

## THE DEVELOPMENT, UPGRADING AND EXPANSION OF TRADITIONAL CHAINS

Many neo-citydwellers feel nostalgic for rural life after their urban migration, and this sense of nostalgia is fostering the spread of traditional foods into urban markets. In the past, such foods were restricted to market villages in production areas (Delvaux and Sinsin, 2003); thus, urbanization tends to expand the spatial and sociological coverage of traditional-food consumption. For example, sprouts of the palmyra palm essentially cultivated in backyards in the north of Benin (e.g. Collines, Atacora and Alibori departments) and the south of the Niger are now transported all the way to Cotonou, where they are cooked (by boiling) for consumption. Therefore, consumption extends to urban areas and reaches new consumer groups.

The baobab fruit is used as a supplementary food for infants in rural areas. With urbanization, new enterprises are helping to promote the remarkable nutritional benefits of this food. In Cotonou, some small-scale enterprises offer powdered infant formulas, while others sell energy drinks in pasteurized bottles. These enterprises have developed both innovative technologies and new products, which are marketed through an increasing number of neighbourhood convenience stores in Cotonou. Baobab juice is also served at coffee breaks and in cocktails.

Other conventional sectors, such as beekeeping, are being upgraded with the adoption of more efficient techniques to expand production and markets.

## SMALL BUSHMEAT, A MAJOR ILLEGAL SEGMENT

The term "small bushmeat" refers to products derived from small-sized animals collected traditionally in the wild for food use. It encompasses diverse species of birds, snails, rodents (such as grasscutters, *Thryonomys swinderianus*, also known as cane rats),

reptiles, amphibians, insects, shellfish and molluscs (Sinsin and Sinadouwirou, 2003). The harvesting, sale and consumption of small bushmeat is illegal in Benin, but most Cotonou restaurants and food stalls sell ready-cooked small-bushmeat dishes. Although the consumption of small bushmeat is widespread, the supply chain has no legal status. It is not studied, documented, controlled, guided or administered by the official forestry authority.

The small-bushmeat market, invisible but pervasive and known to all, thrives illegally, the result of centuries-old bans, complacency and deficiencies in state control. Since colonial times, Benin's forest authority has fought small-scale rural customary hunting. Repeated bans have encouraged poaching and reinforced the symbolic value of bushmeat consumption. Urban migration and new citydwellers have extended the small-bushmeat market, and multiple supply channels have adapted to all combinations of resources (e.g. various wildlife species and geographical locations) and demand (e.g. short supply chains, cured meat and restaurants).

## NEW PRODUCTION SEGMENTS: GRASSCUTTER, REPTILE AND SNAIL FARMING

New production modes based on small bushmeat are developing to meet urban demand. Specialized breeding farms have been created with significant funding and sophisticated technologies.

Grasscutter meat is highly prized and popular in both urban and rural areas (Sodjinou and Mensah, 2005). Rising demand exceeds supply, estimated at about 200 000 heads per year, equivalent to approximately 500 tonnes of meat (Igué, 1991). Although hunting supplies the majority of grasscutters, Benin has been a pioneer in grasscutter farming since 1985 (Kamoyedji, 1999), and captive-breeding techniques were developed several decades ago (Mensah, 2003). Grasscutter meat is marketed at sales points spread throughout urban areas. Mensah (2006) underscored the lack of industrial processing facilities, however.

For other wild species, such as porcupines, the domestication process (especially the challenge of captive breeding) is ongoing.

Sales of reptiles are increasing rapidly – not only farmed crocodiles (for both leather and meat) but also native snake species

***Baskets of achatina snails are ready for sale in a market in Cotonou, Benin***

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for meat production and live export. With urbanization, customary bans prohibiting consumption among ethnic groups are disappearing, and the sale and consumption of snake meat is becoming commonplace (Toudonou, Mensah and Sinsin, 2004).

The consumption of achatina snails (*Achatina achatina*, also known as the giant Ghana snail) is also growing rapidly (Sodjinou, Biaou and Codjia, 2003): snail skewers are popular at coffee breaks and cocktail events. Snail farms can produce year-round, although during the rainy season some sales come from wild catches in southern Benin. The supply chain is still limited largely to gathering and rearing, but with rising demand, breeding farms are developing quickly. The annual supply of snails is estimated at 75.5 tonnes of meat, and the sale price is higher than that of fish, beef, sheep and kid goat.

## EVOLUTION OF FOREST PRODUCT CHAINS: DOMESTICATION, PROCESSING AND MARKETING

Considerable change is being observed in forest-food supply chains in Benin today, driven largely by urban demand (Igué and Puech, 2008):

- a transition from gathering to domestication and farming (e.g. for palmyra palm, mushrooms, snails, grasscutters, snakes and honey);
- the structuring of value chains, with well-defined marketing chains;
- the development of upstream processing activities between the production and marketing stages (e.g. for palmyra palm, snails, grasscutters, *Irvingia* spp., néré and shea);
- the diversification of sales and consumption channels according to spatial and sociological changes in the urban space.

## CONCLUSION

Urbanization is inducing structural changes in the demand for forest foods. The growing economic contribution of the forest sector in Benin (FAO, 1999), and especially of forest foods, poses challenges for Benin's forest administration in redefining public forest policy through a participatory approach involving rural communities (Bertrand *et al.*, 2006). There is an urgent need for a new legal and administrative framework that promotes the sustainable management of the forest resource, including the food products now in such high demand, and the domestication of certain bushmeat species.

The country cannot afford to overlook the small-bushmeat industry and cannot continue to prohibit the industry if the ban remains unenforced. A top priority is to tackle issues surrounding the small-bushmeat industry through the creation of local wildlife management programmes and local regulation of hunting, with fiscal regulations applying to the bushmeat supply chain.

The contribution of forest products to urban food supply should be viewed in the context of food scarcity risks in large cities. What role can the rural, urban and peri-urban forest sectors play in nutrition and health? This public-policy challenge requires much more coordination between the forestry, agriculture (food security) and health (nutrition) administrations. ◆

## References


**Assogba, T.** 2007. *Evaluation de la diversité des arbres médicinaux épargnés dans les terroirs agricoles et analyse de leurs circuits de commercialisation sur les grands marchés du Sud du Bénin*. Cotonou, Benin, FSA.

**Bertrand, A., Agbahungba, G. & Tonou, P.** 2009. *Contribution du secteur forestier à l'économie du Bénin*. Final report, volumes 1, 2 & 3. Cotonou, Benin, Edenia Consult Tanja & Beged-Conseil.

**Bertrand, A., Montagne, P., Serre-Duhem, C. & Raharimaniraka, L.** 2006. Nouvelles politiques forestières et gestion économique publique des filières des produits forestiers non ligneux. *In* A. Bertrand, P. Montagne & A. Karsenty, eds. *Forêts tropicales et mondialisations: les mutations des politiques forestières en Afrique francophone et à Madagascar*. Paris, CIRAD, L'Harmattan éditeur.

**Codjia, J.T.C., Assogbadjo, A.E. & Mensah Ekué, M.R.** 2003. Diversité et valorisation au niveau local des ressources végétales forestières alimentaires du Bénin Cahiers d'études et de recherches francophones. *Agricultures*, 12(5): 321–331.

**Delvaux, C. & Sinsin, B.** 2003. Gestion intégrée des plantes médicinales dans la région des Monts Kouffé. *In* N. Sokpon, B. Sinsin & O. Eyog-Matig, eds. *Actes du IIè Séminaire international sur l'Aménagement intégré des forêts naturelles des zones tropicales sèches en Afrique de l'Ouest, Parakou, Bénin, 25–29 juin 2001*, pp. 389–405. Cotonou, Benin, FSA.

**FAO.** 1999. Document national de prospective: Bénin. Rome.

**Gnimadi, A.** 2008. Etude pour l'identification des filières agroindustrielles prioritaires (BENIN). No. de mission du consultant: TE/RAF/07/A01-1751-2008.

**Government of United States of America.** 2013. The world fact book (available at: www.cia.gov/library/publications/the-world-factbook/).

**Gschladt, W.** 1972. Le Rônier au Dallol Maouri – Niger. *Bois et Forêts des Tropiques*, 145, September–October.

**Igué, J.O.** 1983. *L'officiel, le parallèle et le clandestin: commerces et intégration en Afrique de l'Ouest*. Politique Africaine No. 9. Paris.

**Igué, J.O.** 1991, *Le commerce de l'aulacode et de sa viande au Bénin*. Cotonou, Benin, GTZ/PPEAu.

**Igué, J.O. & Puech, F.** 2008. *Plaidoyer pour la structuration du secteur informel au Benin*. Cotonou, Benin, PASP Com. 2.

**Kadevi, K.** 2001. Statistiques sur les produits forestiers non ligneux (PFNL) dans la République Togolaise. Programme de partenariat CE-FAO (1998–2001). B7-6201/97-15/VIII/FOR/ROJET GCP/INT/679/EC. Rome, FAO.

**Kamoyedji, I.** 1999. Impact de l'élevage des aulacodes sur les revenus des éleveurs: cas de la commune d'Abomey-Calavi. Mémoire

présenté pour l'obtention du Diplôme de Formation Supérieure, Planification Régionale et Aménagement du Territoire, DFS/PRAT, Ouagadougou.

**Lebel, F.** 2003. L'importance des produits forestiers non ligneux pour les ménages agricoles de la région de Thiès, Sénégal. M.Sc. thesis. Québec, Canada, Université de Laval.

**Mensah, R.M.O.B.A.D-G.** 2006. *Contribution des institutions de micro finance au financement des exploitations aulacodicoles au Bénin: Cas du PADME*. Mémoire de fin d'études, ENEAM/UAC/Bénin.

**Mensah, G.A. & Ekué, M-R.M.** 2003. *L'essentiel en aulacodiculture*. RéRE/KIT/IUCN/CBDD. République du Bénin/Royaume des Pays-Bas.

**Sinsin, B. & Sinadouwirou, T.** 2003. Valorisation socio-économique et pérennité du *Pentadesma butyracea* Sabine en galeries forestières au Bénin Cahiers d'études et de recherches francophones. *Agricultures*, 12(2): 75–79.

**Sodjinou, E., Biaou, G. & Codjia, J.T.C.** 2003. Commercialisation des escargots géants africains (achatines) dans les Départements de l'atlantique et du littoral au Sud-Bénin. *Annales des sciences agronomiques du Bénin*.

**Sodjinou, E. & Mensah, G.A.** 2005. Analyse technico-économique de l'aulacodiculture au Nord-Bénin: Déterminants d'adoption. International Forum on Promoting Grass-cutter for Business in West Africa, Accra, Ghana, December 2005.

**Toudonou, A.S.C., Mensah, G.A. & Sinsin, B.** 2004. Le serpent: une nouvelle ressource alimentaire dans les départements du centre et du sud du Bénin. *Bulletin of Agricultural Research of Benin*, 45.

**United Nations Population Division.** 2008. *An overview of urbanization, internal migration, population distribution and development in the world*. New York, USA. ◆

# Forests, food security and gender

*L. Stloukal, C. Holding, S. Kaaria, F. Guarascio and N. Gunewardena*

FAO/G. BIZZARRI

***A woman and a girl harvest coffee beans in a homegarden in Lempira Sur, Guarita, Honduras. Women in developing countries are frequently disadvantaged in their access to economic opportunities in the forest sector***

*Forestry and agroforestry systems are not gender-neutral. Empowering women could create significant opportunities for greater food security in developing countries.*

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Forests and trees on farms are a direct source of food, cash income and a range of subsistence benefits for billions of people worldwide, but there are major differences in the benefits that accrue to women and men. Women in developing countries are frequently disadvantaged in their access to forests and economic opportunities in the forest sector because, compared with men, they usually:

- have lower levels of literacy, education, physical abilities and technical skills, less access to services such as extension and credit, greater constraints on their time and mobility, and limited access to markets and market-related information;
- face discrimination in conventional forest, tree and tree-product ownership regimes;
- shoulder the burden of domestic and childcare responsibilities;
- participate less in rural institutions, for example forest-user groups;
- face gender-differentiated behavioural norms and social perceptions of women's roles.

These disadvantages often result in gender disparities in, for example, access to and use of forest foods, woodfuel[1] and fodder for livestock; forest management;

[1] Woodfuel comprises unprocessed wood (firewood, called "fuelwood" here) and processed wood products, such as charcoal and sawmill offcuts, used for fuel.

and the marketing of forest and tree products. This article expands on some of these disparities and makes a case for gender equity in increasing food security and nutrition in poor rural communities.

## GENDER DIMENSIONS OF THE FOREST–FOOD SECURITY NEXUS

### Food from the forest

Wan, Colfer and Powell (2011) demonstrated that the gender-based division of agricultural labour and food production, combined with the fact that women often have fewer alternative income-earning opportunities than men, means that women tend to collect forest foods to supplement the nutrition of their households. Women play a particularly important role in collecting and processing edible wild plants from forests, as well as in the preparation of household meals by using forest foods to cook (for example) soups, stews and relishes (Vinceti, Eyzaguirre and Johns, 2008; FAO, 2012). Women often have substantial knowledge concerning the identification, collection and preparation of highly nutritious forest foods that can complement and add flavour to the staples of family meals. In addition, income generated by women from these activities adds to the purchasing power of households and therefore their food security. Men are more likely than women to be responsible for collecting wild honey, birds' eggs and insects, hunting wild animals, and fishing (Shackleton *et al*., 2011; IFAD, 2008). In some places (such as in parts of the Congo Basin and the Peruvian Amazon), such activities provide the primary sources of animal protein for rural people (FAO, 1992).

### Agroforestry

There is evidence that agroforestry activities are often gender-differentiated: while men are usually interested in trees (often of only one or two species) for commercial purposes, women are more inclined to favour multipurpose trees of a number of species for subsistence use, such as those that provide food, fuelwood and fodder and help improve soil fertility. A review of 104 studies of gender and agroforestry in Africa (Kiptot and Franzel, 2011) confirmed that women's participation is very high in enterprises such as the production and processing of indigenous fruit and vegetable products, apparently because indigenous species require fewer labour inputs. The review also showed that, in Africa, the extent of women's involvement relative to men in activities such as soil-fertility management, fodder production and woodlot-growing is fairly high in terms of the participation of female-headed households but low when measured by the area of land such households allocate to these activities and the number of trees they plant. In cases where women have low involvement, this is due mostly to a scarcity of resources, especially land and labour (partly because women tend to do more household and care work than men), and to differences in male and female opportunity sets. Some studies have also noted that, compared with men's fields, women's farm plots tend to have a greater number of trees and more species, possibly because women like to have trees near the homestead as well as a diversity of species with which to maintain the health of their children and broaden the household food supply (FAO, 1999).

Tree tenure – the ownership and use rights of trees – is often differentiated along gender lines, and men usually have overall authority over high-value tree products. However, the gendered nature of access to and control of trees, tree products and related resources is often highly complex, depending on social and ecological conditions and factors such as landscape niche, time, species, products and uses (Rocheleau and Edmunds, 1997). In many settings, women's rights are substantial due to the informal (and often negotiable) nature of customary laws and, in some cases, the complementarity of women's and men's productive roles. Women's rights, however, can easily become marginalized or may not be recognized, especially in the introduction of statutory laws and formal administrative procedures at the local to central government level (Quisumbing *et al*., 2001).

Although women often make significant labour contributions to agroforestry (e.g. by planting, weeding and watering trees), their opportunities in the sector are often limited to low-return activities that are of

### Women and forest vegetables in East Usambara

**In the East Usambara Mountains in the northeast of the United Republic of Tanzania, the consumption of traditional leafy vegetables is the best predictor of children's overall micronutrient intake. The majority of leafy vegetables consumed in the area are wild-collected by women in fields, field margins, fallows and agroforests. Survey data show that, in the wet season, 46 percent of children aged 2–5 years consume vegetables on a daily basis, while in the dry season only 22 percent of children are able to do so. Proximity to the forest is a key determinant of vegetable consumption, particularly in the dry season. Local women reported that those who were poor and lived far from the forest had to spend a significant amount of time collecting vegetables. In addition, even though they had legal access rights, many women were hesitant about entering reserved forests to collect vegetables for fear of being suspected of illegal activities or of encountering others engaging in such activities (e.g. pit-sawing, mining and hunting). In this setting, having areas with tree cover on the family farm and near the home supports year-round access to vegetables, with the potential to decrease women's workloads and improve the nutrition of their families.**

***Source:*** **Powell, Hall and Johns (2012)**

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***A woman shows how to harvest mfumbwa leaves* (Gnetum africanum)*, a popular wild food in central Africa, without destroying the plant. Women play an important role in collecting and processing edible wild plants from forests and preparing them for household meals***

little or no interest to men, while men tend to control the production and marketing of high-value products as well as the use of the income so generated (Rocheleau and Edmunds, 1997). Tree products such as charcoal, logs, timber, large branches and poles are typically considered male domains. Thus, in the Luo and Luhya communities in western Kenya, women have the right to collect and use fruits but are restricted from harvesting high-value timber trees. On the other hand, species such as *Sesbania sesban*, which produces good fuelwood and can help improve soil fertility, is considered a women's tree, and therefore women have the right to plant, manage and use it as they please (Franzel and Kiptot, 2012).

Rocheleau and Edmunds (1997) reported that, among the Akamba community of eastern Kenya, tree-planting and felling were primarily the domains of men, while women enjoyed use and access rights to fodder, fuelwood, fruits and mulch. Gender-differentiated rights and responsibilities in agroforestry are also an important determinant of the adoption of agroforestry technologies and the use of related services, and this differential uptake of technologies may (if other things remain the same) further perpetuate existing gender inequalities.

**Woodfuel and household energy**

Limited access to woodfuel – for example due to environmental degradation or local forest regulations – can cause households to change what they eat, potentially leading to malnutrition. Similarly, boiling water insufficiently to save fuel can contribute to the consumption of contaminated water and poorly prepared food, with potentially life-threatening consequences, especially for children, pregnant women, the malnourished and the sick.

In many agrarian settings, women and girls have the primary responsibility for collecting fuelwood for household use and may have to walk for several hours, frequently in insecure conditions, to do so. In refugee and conflict situations, women are particularly vulnerable to gender-based violence while collecting fuelwood (WFP, 2012).

Shrinking access to fuelwood near the home – which is becoming a pressing reality in many developing countries – and the time taken to collect it often mean that women have less time for other activities (Wan, Colfer and Powell, 2011). Gbetnkom (2007) concluded that constraints on women's income-earning potential caused

*A woman carries fuelwood near Mbeya, the United Republic of Tanzania. Women and girls often have the primary responsibility for collecting fuelwood for household use and may have to walk for several hours, frequently in insecure conditions, to do so*

FAO/A. CONTI

by the scarcity of fuelwood may have significant impacts on household food security. The increased time spent gathering wood leaves less time for cash-earning activities and for tasks to support the food security and health of families, while the purchase of increasingly expensive woodfuel leaves less money to buy food.

Women are not always the main fuelwood collectors (Sunderland *et al*., 2012). For example, when the distances become too great for fuelwood collection on foot, or where there are naturally low densities of fuelwood (e.g. in the Kalahari), men tend to assume the role of fuelwood collection, making use of transportation such as donkey carts and small trucks. Men are also the main collectors of woodfuel, including charcoal, for sale (Zulu and Richardson, 2013). In Latin America, men are overwhelmingly responsible for woodfuel collection.

With regard to the cooking environment, the combustion of biomass (including woodfuel) releases significant quantities of pollutants that damage the health of those who do the cooking, the vast majority of whom are women. Exposure to indoor smoke has been found to be responsible for 39 percent of deaths due to chronic pulmonary disease in women, compared with 12 percent in men (Wan, Colfer and Powell, 2011; Rehfuess, 2006). Disease and nutrition are linked: infections associated with wood-smoke exposure significantly increase women's nutrient requirements (e.g. vitamin A), and those who are micronutrient-deficient are more likely to develop infections after exposure to wood smoke.

**Fodder for livestock**

Many tree species found in forests, woodlands and parklands and on farms are used for animal feed; they may be browsed directly by roaming livestock or collected and fed to livestock in stalls. It has been estimated, for example, that 75 percent of tree species in tropical Africa are used as browse by domestic livestock such as sheep, goats, cattle, camels and donkeys (FAO, 1991). Women (and children) play crucial roles in gathering animal fodder (including from trees), feeding and grazing animals, cleaning animal sheds, and composting animal waste. These activities contribute significantly to domestic livestock production, which in turn influences milk and meat supply and contributes to household income. Tree-based fodder is also used to sustain draught animals for ploughing and in the production of manure – which increases soil fertility and is used as cooking-fuel (especially when woodfuel is in short supply).

FAO/C. DOWSETT

*Farmer Patricia Oduor and extension worker Gabriel Malowa chat in an agroforest in Siaya District, Kenya. Women and men often have highly specialized knowledge of forest flora and fauna, but it is not always acknowledged or used in modern systems*

**Forests and climate-change adaptation**

Women may be more vulnerable than men to the effects of climate change because they are more likely to be poor and dependent on natural ecosystems threatened by climate change (IPCC, 2007; Lambrou and Nelson, 2010). They are also effective actors and change agents for climate-change mitigation and adaptation (Peach Brown, 2011). Women often have a strong body of knowledge and expertise that can be used in strategies for disaster reduction and climate-change mitigation and adaptation. Moreover, women's responsibility in households and communities as stewards of forest foods and other forest-related and tree-related resources means they are well-placed to develop livelihood strategies adapted to changing environmental conditions. As natural-resource managers, women influence the total amount of genetic diversity conserved and used, often working to counter decreases in biodiversity caused in part by the favouring by men of cash-oriented monocultures (World Bank, FAO and IFAD, 2008). It follows that forest policies and programmes that aim to be socially responsive should take into account the gendered dimensions of resource use, needs, access, knowledge and strategies for coping with climate change.

**GENDER DIFFERENCES IN FOREST-RELATED KNOWLEDGE**

Men's forest-related knowledge is often regarded as knowledge that "counts", and the knowledge held by women is not always properly recognized in forest management plans and forest use. Both women and men often have highly specialized knowledge of forest flora and fauna in terms of species diversity, location, harvesting and hunting patterns, seasonal availability, uses for various purposes, and conservation practices.

Much of the existing literature, typically based on case studies, paints a stylized picture in which women derive their knowledge from their specialized roles in the collection and processing of forest products for direct household use and limited sale in local markets, while men tend to specialize in the harvesting of timber products and wild meat for cash income and marketing. However, the extent to which such findings can be generalized is unclear. Data from 36 long-term studies of forest-proximate communities in 25 countries in Africa, Asia and Latin America, representing more than 8 000 households, confirm that women and men tend to collect different forest products (Sunderland, 2011). Contrary to conventional wisdom, however, the data

show that both women and men collect non-timber forest products (NTFPs, which can include woodfuel) primarily for subsistence and that men's sale share is generally higher than women's, except in Africa where the share is roughly equal (Sunderland, 2011). This finding indicates that while gender differences in forest-relevant knowledge exist (particularly about processing and marketing), they may not be as clear as previously thought, and a range of factors – such as marital status, age, wealth and formal education – in addition to gender may co-determine how people use forests.

Nevertheless, women's knowledge tends to be linked more directly to household food and nutrition needs as well as to health and culture, compared with men's knowledge (Daniggelis, 2003). A study in Amazonia (Shanley and Gaia, 2001) found that, compared with men, women were able to identify a broader range of plant species (i.e. trees, vegetables, vines, bushes and herbs) and usable plant parts (i.e. fruits, barks, leaves, seeds and roots). Such knowledge is particularly important in natural disasters and food crises, when the collection and sale of forest products by women often become critical for household survival. In many places, women's familiarity with tree products such as fruits and nuts, medicinal materials and woodfuel plays a crucial role in coping with food shortages. Moreover, the nutritive value of wild foods is often substantial and can be used as a substitute for purchased food items.

Traditionally, women have been the primary domesticators of forest-based food and medicinal plants that are now found in homegardens worldwide (Kumar and Nair, 2004; Eyzaguirre and Linares, 2004). In humid western and southern Africa, rural women play a particularly important role in the cultivation of indigenous fruit trees (e.g. *Irvingia gabonensis*, *Dacroydes edulis* and *Sclerocarya birrea*) (Campbell, 1987). While men may be the nominal owners of trees, women are often responsible for the marketing of fruits and, importantly, are often able to decide how the income is used. Nevertheless, women's participation in tree domestication has been hindered by limited access to and control over land and trees, insufficient information on the requirements and advantages of tree domestication, and substantial periods of production inactivity due to their childbearing and childrearing roles and their heavy workloads in the household (Degrande *et al*., 2007; Degrande, 2009).

## GENDER DIFFERENCES IN FORESTRY VALUE CHAINS

As they are for most primary products originating in developing countries, NTFP value chains are highly gender-specific. In many settings, women deal primarily with products of relatively low economic value, engage in less lucrative informal activities, and do not have the same access to technology, credit, training and decision-making as men. Unsurprisingly, interactions between women and men and the division of labour between them at each stage of a value chain depend heavily on the environment in which they live, their livelihood preferences, and the available technology. In general, women tend to prefer flexible working conditions that do not clash with their day-to-day household responsibilities (CIFOR, 2012).

Engagement in forestry value chains is often crucial for rural women's livelihoods and the well-being of their households. In Ethiopia, for example, sorting and cleaning gums and resins is the primary source of income for 96 percent of the women involved in the activity; in Burkino Faso, women engaged in sorting gum arabic reported that it was their most important source of income for 3–4 months per year (Shackleton *et al*., 2011). Many researchers have also noted that increases in women's incomes have greater impacts on food, health and education expenditure and therefore on overall household well-being than increases in the incomes of men (e.g. Blumberg, 1988; Hoddinott and Haddad, 1991; Kabeer, 2003).

The gender roles in forestry value chains are generally poorly understood and not well supported by policy-makers and service providers, especially those who focus on hi-tech operations or pay less attention to local markets. Gender-sensitive value-chain analyses can identify less-visible gender-sensitive components at various stages of value chains. These might include processing at home; informal trading in neighbourhood markets; and the collection, by men, of certain non-wood forest products such as gums and honey if it requires physically taxing work or is carried out in remote areas. Thus, analysing value chains from a gender perspective can be useful in identifying practical opportunities for improving the livelihoods of the rural poor.

## GENDER BALANCE IN FOREST-USER GROUPS

Strengthening gender equality in rural societies is generally recognized as a necessary prerequisite for increasing agricultural productivity, reducing poverty and hunger, and promoting economic growth. The forest sector provides a broad range of opportunities to empower rural women. Here, we discuss increasing the participation of women in forest-user groups.

Women are generally under-represented in forest-user groups such as village forest committees and community forest associations (Coleman and Mwangi, 2012). In many settings, rules allowing only one person per household to participate in such groups tend to exclude women, and women often become involved in decision-making only after forest and tree resources have become degraded. As a result, community forest groups sometimes enforce rules and regulations that do not fully reflect women's strategic interests and needs.

Female-dominated groups tend to have more property rights to trees and bushes and to collect more woodfuel and less timber than do male-dominated or gender-balanced groups (Sun, Mwangi and Meinzen-Dick, 2011). Gender-balanced groups, on the other hand, perform

consistently better in all forestry functions (e.g. the protection of plantings, forest regeneration, biodiversity conservation, watershed protection and the allocation of forest-use permits). Pandolfelli, Meinzen-Dick and Dohrn (2008) found that gender-balanced groups capitalize on the complementary roles of women and men, mobilize people for collective action, and enable better access to information and services from external agents. The greater involvement of women in forest governance may thus help ensure that forest policies and planning are more sensitive to the food-security needs of communities.

Sun, Mwangi and Meinzen-Dick (2011) found that the relationship between the gender composition of groups and collective outcomes is not linear. Evidence compiled by Agarwal (2001, 2010), Sun, Mwangi and Meinzen-Dick (2011) and Coleman and Mwangi (2012) suggests that when women constitute one-quarter to one-third of the membership of local forest management institutions, the dynamic changes in favour not only of the consideration of women's use of and access to forest resources but also towards more effective community forest management decision-making and management as a whole.

The active and effective participation of women in forest institutions is governed by a number of factors in addition to the proportion in which they are represented. Agarwal (2010) and Coleman and Mwangi (2012) found that, in Honduras, India, Nepal and Uganda, the gender composition of forest councils and the age and education levels of the women on those councils significantly affected women's attendance at meetings and the likelihood they would speak up on critical issues.

There is evidence that women's participation in the decision-making of forest institutions such as forest-user groups reduces the level of gender-based conflict. This is because participation leads to new rules of access that take women's needs into account, and therefore their activities are less likely be criminalized or viewed as infringements.

***A woman cuts wood on a circular saw in a wood market in Ulaanbaatar, Mongolia. The gender roles in forestry value chains are generally poorly understood and not well supported by policy-makers and service providers***

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## CONCLUSION

Forestry and agroforestry systems are not gender-neutral. Compared with men, women are frequently disadvantaged – for a range of interrelated cultural, socio-economic and institutional reasons – in their access to and control over forest resources and in the availability of economic opportunities.

Empowering women in the forest sector can create significant development opportunities for women (e.g. in terms of income, livelihood diversification, business skills, independence and self-esteem) and can have important spillover benefits for their households and communities in terms of food security, health and education. Women need to be adequately represented in forest-related institutions, accepted as stakeholders with specific views and interests, and empowered (e.g. through formal education, training and support for income generation) to have a say in transformative decisions. Efforts to promote women's inclusion in forest-related institutions will help to maximize synergies between the forest sector and food security, for the benefit of all.

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## References

**Agarwal, B.** 2001. Participatory exclusions, community forestry and gender: an analysis for South Asia and a conceptual framework. *World Development*, 29(10): 1623–1648.

**Agarwal, B.** 2010. Does women's proportional strength affect their participation? Governing local forest in South Asia. *World Development*, 38(1): 98–112.

**Blumberg, R.L.** 1988. Income under female versus male control: hypotheses from a theory of gender stratification and data from the third world. *Journal of Family Issues*, 9(11): 51–84.

**Campbell, B.M.** 1987. The use of wild fruits in Zimbabwe. *Economic Botany*, 41(3): 375–385.

**CIFOR.** 2012. *Forests: gender and value chains*. CIFOR Info Brief No. 49. Center for International Forestry Research (available at: www.cifor.org/online-library/browse/view-publication/publication/3752.html).

**Coleman, E. & Mwangi, E.** 2012. Women's participation in forest management: a cross country analysis. *Global Environmental Change*, in press.

**Daniggelis, E.** 2003. Women and 'wild' foods: nutrition and household security among Rai and Sherpa forager-farmers in eastern Nepal. *In* P.L. Howard, ed. *Women & plants: relations in biodiversity management and conservation*. New York, USA, and London, Zed Books and St. Martin's Press.

**Degrande, A.** 2009. *Growing out of poverty: tree cultivation in West and Central Africa for home use and markets*. IFAD Technical Advisory Note (TAN)-697. Yaounde, World Agroforestry Centre and Rome, International Fund for Agricultural Development.

**Degrande, A., Essomba, H., Bikoue Mekongo, C. & Kamga, A.** 2007. *Domestication, genre et vulnérabilité. Participation des femmes, des jeunes et des catégories les plus pauvres à la domestication des arbres agroforestiers au Cameroun*. ICRAF Working Paper No. 48. Yaounde, ICRAF-WCA/HT.

**Eyzaguirre, P.B. & Linares, O.F.** 2004. *Home gardens and agrobiodiversity*. Washington, DC, Smithsonian Books.

**FAO.** 1991. *Household food security and forestry: an analysis of socio-economic issues*. Rome (available at: www.fao.org/docrep/006/t6125e/t6125e00.htm).

**FAO.** 1992. *Forests, trees and food*. Rome (available at: www.fao.org/docrep/006/U5620E/U5620E00.HTM#TopOfPage).

**FAO.** 1999. *Agroforestry parklands in sub-Saharan Africa*. FAO Conservation Guide No. 34. Rome.

**FAO.** 2012. *Forests for improved nutrition and food security*. Rome (also available at: www.fao.org/docrep/014/i2011e/i2011e00.pdf).

**Franzel, S. & Kiptot, E.** 2012. Gender and agroforestry in Africa: who benefits? *In* P.K.R. Nair & D. Garrity, eds. *Agroforestry: the future of global land use*. Springer.

**Gbetnkom, D.** 2007. *Forest management, gender and food security of the rural poor in Africa*. World Institute for Development Economics Research Paper No. 2007/86. United Nations University.

**Hoddinott, J. & Haddad, L.** 1991. Household expenditure, child anthropometric status and the intra-household division of income: evidence from Côte d'Ivoire. *IFPRI Discussion Paper #155*. Washington, DC, International Food Policy Research Institute.

**IFAD.** 2008. *Gender and non-timber forest products: promoting food security and economic empowerment* (available at: www.ifad.org/gender/pub/timber.pdf). Rome, International Fund for Agricultural Development.

**IPCC.** 2007. *Contribution of working groups I, II and III to the fourth assessment report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland, Intergovernmental Panel on Climate Change.

**Kabeer, N.** 2003. *Gender mainstreaming in poverty eradication and the Millennium Development Goals*. Ottawa, International Development Research Centre.

**Kiptot, E. & Franzel, S.** 2011 *Gender and agroforestry in Africa: are women participating?* Occasional Paper No. 13. Nairobi, World Agroforestry Centre.

**Kumar, B.M. & Nair, P.K.R.** 2004. The enigma of tropical home gardens. *Agroforestry Systems*, 61(1–3): 135–152.

**Lambrou, Y. & Nelson, S.** 2010. Farmers in a changing climate: does gender matter? (available at: www.fao.org/docrep/013/i1721e/i1721e00.htm).

**Pandolfelli, L., Meinzen-Dick, R. & Dohrn, S.** 2008. Introduction: gender and collective action: motivations, effectiveness and impacts. *Journal of International Development*, 20(1): 1–11.

**Peach Brown, H.C.** 2011. Gender, climate change and REDD+ in the Congo Basin forests of Central Africa. *International Forestry Review*, 13(2): 163–176.

**Powell B., Hall, J. & Johns, T.** 2011. Forest cover, use and dietary intake in the East Usambara Mountains, Tanzania. *International Forestry Review*, 13(3): 305–317.

**Quisumbing, A.R., Otsuka, K., Suyanto, S., Aidoo, J.B. & Payongayong, E.** 2001. *Land, trees, and women: evolution of land tenure institutions in western Ghana and Sumatra*. Washington, DC, International Food Policy Research Institute.

**Rehfuess, E.** 2006. Fuel for life: household energy and health (available at: www.who.int/indoorair/publications/fuelforlife/en/).

**Rocheleau, D. & Edmunds, D.** 1997. Women, men and trees: gender, power and property in forest and agrarian landscapes. *World Development*, 25(8): 1351–1371.

**Shackleton, S., Paumgarten, F., Kassa, H., Husseelman, M. & Zida, M.** 2011. Opportunities for enhancing women's economic empowerment in the value chains of three African non-timber forest products (NWFPs). *International Forestry Review*, 13(2): 136–151.

**Shanley, S. & Gaia, G.R.** 2001. Equitable ecology: collaborative learning for local benefit in Amazonia. *Agriculture Systems*, 73: 83–97.

**Sun, Y., Mwangi, E. & Meinzen-Dick, R.** 2011. Is gender an important factor influencing user groups' property rights and forestry governance? Empirical analysis from East Africa and Latin America. *International Forestry Review*, 13(2): 205–219.

**Sunderland, T.** 2011. In the management of forests, gender matters. CIFOR forest blog, 23 July 2011. *Non-Wood News,* 23.

**Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V. & Shively, G.** 2012. Myths and realities about men, women and forest use: a global comparative study (available at: www.slideshare.net/CIFOR/myths-and-realities-about-men-women-and-forest-use).

**Vinceti, B., Eyzaguirre, P. & Johns, T.** 2008. The nutritional role of forest plant foods for rural communities. *In* C.J.P. Colfer, ed. *Human health and forests: a global overview of issues, practice and policy*. London, Earthscan.

**Wan, M., Colfer, C.J.P. & Powell, B.** 2011. Forests, women and health: opportunities and challenges for conservation. *International Forestry Review*, 13(3): 369–387.

**WFP.** 2012. *Handbook on safe access to firewood and alternative energy (SAFE)* (available at: http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp252989.pdf). Rome, World Food Programme.

**World Bank, FAO & IFAD.** 2008. *Gender in agriculture sourcebook* (available at: http://worldbank.org/genderinag).

**Zulu, L.C. & Richardson, R.B.** 2013. Charcoal, livelihoods, and poverty reduction: evidence from sub-Saharan Africa. *Energy For Sustainable Development*, 17(2): 127–137. ◆

# Forests, trees and resilient households

*P. Dewees*

*Building greater economic and ecological diversity into landscapes is a key to increasing the resilience and therefore food security of rural households.*

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Appreciation of the many ways in which forests and trees outside forests contribute to food security is growing, but their role in increasing the resilience of households and ecosystems is less well known. Yet resilience is an important component of food security and is likely to become more so as factors such as climate change and global population growth increase the likelihood of future shocks. This article explores some of the ways in which forests and trees contribute to the capacity of households to withstand tough times, and it describes policy responses to encourage the integration of forests and trees in agricultural systems to increase the resilience of both people and the environment.

***People displaced by flooding in Pakistan shelter their livestock among trees. Forests and trees outside forests can contribute to the capacity of households to withstand tough times***

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*Chopped leaves of* **Gnetum** *spp., an NTFP, are offered for sale in a market. NTFPs are part of many coping strategies in which households increase their NTFP extraction to smooth out consumption levels when agricultural or other outputs fall*

**FOOD SECURITY AND RESILIENCE**

Hollings (1973) used the term "resilience" to mean the ability of ecological systems to respond to external forces and to persist in the face of those external forces. He distinguished resilience from stability, which he defined as the ability of a system to return to an equilibrium state after a disturbance. He pointed out that ecological systems can be resilient and still fluctuate greatly.

Walker *et al*. (2004) noted that the stability of human and natural systems depends on three complementary attributes: resilience, adaptability and transformability, where adaptability is the capacity to modify a system in ways that increase the capacity for resilience, and transformability is the ability to make a radical change when the existing system is no longer viable.

Shocks at the household level – whether from drought, illness, the loss of employment, crop losses from disease, or fire, flooding and other natural disasters – can undermine household food security. Longer-term stresses, such as those associated with population growth and climate change, can interact with and exacerbate short-term stresses.

Time is an important variable in assessing resilience, adaptability and transformation, and it is possible that adaptation that increases food security in one time period can have a negative effect on resilience in another (Carpenter *et al*., 2001). For example, the advent of chainsaws and their incorporation into farming systems helped agricultural societies by enabling them to quickly clear large areas of forest to create new agricultural land. However, as the forest frontier became constrained and fallowing was no longer tenable for maintaining soil fertility, the resilience of the system was compromised.

**THE ROLE OF FORESTS AND TREES IN RESILIENCE**

The roles of trees outside forests are well known to farmers but tend to be poorly understood by technical specialists, planners and policy-makers and have mostly been overlooked in national statistics and economic accounts (Bellefontaine *et al*., 2002). Farmers have been incorporating trees into their farming systems – and increasing the resilience of those systems – for thousands of years through intensive management strategies, such as in the sophisticated homegardens of Indonesia (Michon, Mary and Bompard, 1986). They have also been retaining trees in less explicit processes of land-use change, for example by ensuring that valuable indigenous trees for food production, like the shea nut tree in western arid Africa, are retained in farm fields as new agricultural lands are cleared (Wilson, 1989).

There is growing awareness of the extent of tree-involved farming practices and their increasing prominence as a feature of agricultural land use. Even in modern agricultural systems, the boundaries between the forest and the farm have become increasingly obscured; there is a trend to revert land-use systems from their often highly simplified states towards more ecologically complex systems.[1] The potential impact of this trend on food security is profound. The resilience of complex land-use systems has analogues in ecological science, where empirical evidence shows that complex ecosystems are far more resilient than simple ones (although arguably less productive, at least in the short term; see Hollings and Goldberg, 1971). Land-use systems that incorporate the use and management of forests and trees can increase resilience in a number of ways, some of which are discussed below.

**Trees and forests as safety nets**

The view that trees and forests can provide important risk-reduction functions at the household level is well-established in the literature. Looking at the problem of risk management, Delacote (2007) distinguished the extraction of non-timber forest products

[1] In the European Union, for example, farmers are required to undertake actions to conserve critical natural habitats in farmland in order to receive subsidies under the Common Agricultural Policy.

**TABLE 1. Coping strategies employed by households in response to anticipated and unanticipated risk, two villages in South Africa**

| Coping strategy | Percentage of households employing coping strategy | | | $X^2$ | Significance |
|---|---|---|---|---|---|
| | Total | Wealthiest | Poorest | | |
| Kinship | 85 | 80 | 90 | 1.9 | > 0.05 |
| Reduced spending | 74 | 84 | 64 | 5.2 | < 0.05 |
| Changed diet | 72 | 84 | 60 | 7.1 | < 0.05 |
| Saving/budgeting | 72 | 88 | 56 | 12.7 | < 0.05 |
| Sale of NTFPs | 70 | 68 | 72 | 0.2 | > 0.05 |
| Selling livestock | 44 | 58 | 30 | 7.9 | < 0.05 |
| Savings clubs | 41 | 64 | 18 | 21.9 | < 0.05 |

*Source:* Paumgarten (2007)

(NTFPs)[2] in two ways: as a *diversification strategy*, in which households increase their participation in a wide range of possible welfare-improving activities; and as a *coping strategy*, where households increase their extraction of NTFPs to smooth out consumption levels when agricultural or other outputs fall. A number of studies have examined the role of NTFPs from a diversification perspective (addressing the question of the share of household income and consumption that is met by NTFPs), but relatively few have reported findings about how NTFPs contribute to smoothing consumption as a coping strategy.

Paumgarten (2007) examined the safety-net function of NTFPs in two rural villages in South Africa by looking at how households coped with expected and unexpected crises over a two-year period (Table 1). The most important coping strategy used by all classes of household was a reliance on kinship groups and community support networks to help compensate for income losses. More generally, however, the study showed that differences in how the wealthiest and poorest households responded to stress were a function of differences in their access to assets: wealthier households were more able to sell livestock or rely on savings than were poorer households. The study also showed that while poor and wealthy households were both likely to sell NTFPs, this was an especially important strategy for poor households because NTFPs were among the few marketable assets at their disposal.

These findings are echoed elsewhere. Shackleton (2006), Kayambazinthu *et al*. (2005), FAO (2005) and Barany *et al*. (2004) all pointed to the importance of NTFP sales to households afflicted by HIV/AIDS. Tairo (2007) and Ngaga, Munyanziza and Masalu (2006) showed the role of southern Africa's miombo woodlands as providers of "famine foods" and as natural insurance. Using seasonal household data for rural Malawi, Fisher and Shively (2005) found that households experiencing an income boost (e.g. from remittances or a good harvest) depended less on forest product extraction than those not receiving such a boost. Hegde and Bull (2008) documented the role that miombo resources play when shocks hit household assets: households experiencing illness shocks increased their consumption of environmental resources (including the sale of NTFPs) by 42 percent. In their study of rates of forest extraction in mountainous parts of Viet Nam, Volker and Waibel (2010) showed that households affected by health shocks to economically active household members and severe weather shocks were more likely to extract forest products, especially woodfuel, than other households. A common finding in many of these studies is that, during times of stress, NTFPs are sold to generate income that can be used to purchase food, especially by the very poor.

It seems clear, therefore, that forests and trees outside forests can act as crucial safety nets for food security and are often important components of coping strategies for the very poor. However, their use in short-term coping strategies may jeopardize their role in diversification strategies, as is explored below using the case of woodfuel.

## Income, risk management and woodfuel

Reliance on woodfuel markets to generate income during periods of stress has been widely observed but seldom well-documented. In his assessment of household responses to food shortages in Malawi in 2003, Zulu (2010) identified a range

**TABLE 2. Strategies to adapt to famine employed by households in southern Malawi, 2003**

| | Strategy | Percent ($n$ = 381) |
|---|---|---|
| 1 | Reduced number of meals per day | 48.0 |
| 2 | Substituted maize with non-staple foods (e.g. pumpkins, potatoes and wild foods) | 45.9 |
| 3 | Engaged in piece-work to earn income to buy food | 39.1 |
| 4 | Used food grants from the government and other agencies | 32.8 |
| 5 | Produced or sold charcoal to buy maize | 29.7 |
| 6 | Sold livestock to buy food or exchanged livestock for food | 16.8 |
| 7 | Sold other crops (e.g. vegetables, cassava and potatoes) to buy maize | 16.0 |
| 8 | Sold firewood to buy maize | 11.8 |
| | Did not encounter a food deficit | 14.2 |

*Source:* Paumgarten (2007)

[2] NTFPs encompass all biological materials other than timber (but may include woodfuel) which are extracted from forests for human use.

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*A beneficiary of an FAO project implemented in the wake of Hurricane Ivan in Grenada mills a tree trunk to be used for local house-building. Forest-based employment can be important in coping strategies in the face of disaster*

of adaptation strategies (Table 2). More than 40 percent of surveyed households reported that, under famine conditions, they used income from the sale of charcoal or firewood to purchase maize.

There is a risk that reliance on woodfuel markets in hard times might mitigate the short-term risk at a longer-term environmental (and economic) cost. Thus, two questions emerge about the role of woodfuel in food security: do woodfuel markets generate sufficient income to mitigate food insecurity, and what is the impact of this on the resource base?

Woodfuel fits two risk-management niches in rural households – as a diversification strategy some of the time, and as a coping strategy during times of environmental or other stress. The impacts and outcomes of woodfuel production and sale on poverty and the resource base should be considered from both perspectives. If, as Delacote (2007) suggested, risk-diversification strategies are likely to be more forest- and tree-conserving (by raising the value of NTFPs and therefore the incentive to conserve forests to ensure continued NTFP production), we would expect to find cases where woodfuel markets have stimulated the development of sustainable forest and tree management systems.

There are such examples. On the plains of the Gran Chaco in the Argentine province of Salta, management systems have been devised to bring large areas of degraded woodland into production, with one objective being charcoal production (Bucher and Huszar, 1999). The system relies on integrating livestock management with woody biomass management, over a 20–40-year cycle, with the objective of landscape restoration. In the longer term, however, the system will need to better serve the interests of local farmers, who continue to depend on agricultural land clearance to meet livelihood objectives.

The conventional wisdom in much of Africa is that charcoal markets drive deforestation and forest degradation. Mwampanda *et al*. (2013) pointed out, however, that charcoal itself is seldom the culprit because deforestation tends to be driven more by agricultural expansion, of which charcoal is a byproduct. The capacity of dry woodlands to regenerate and recover is well known, for example in Senegal (Ribot, 1999) and Zambia (Chidumayo and Gumbo, 2013). In his assessment of forest degradation in Senegal, Wurster (2010) found that forests in areas managed for charcoal production were equally degraded compared with areas where charcoal production was absent.

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*A man and a woman sell firewood in a wood market in Phnom Penh, Cambodia. There is a risk that reliance on woodfuel markets in hard times might mitigate the short-term risk at a longer-term environmental and economic cost*

Nevertheless, the most vulnerable people, who may depend on burning charcoal as a safety net during times of environmental stress, often live in areas that are ecologically highly fragile. It is this combination – low ecological resilience combined with high economic vulnerability – that can bring the temporal dimension of risk management into play. As a coping strategy, risk management that depends on cutting woodlands to produce charcoal may simply shift the risk to a period in the future, before the woodlands have had a chance to recover, and resilience in one period may be gained at the expense of resilience in another.

### Ambiguous relationship between income and food security

Higher income may not lead to improved food security if households choose to spend the additional income in ways that do nothing to improve food security, such as on social events or clothing. Moreover, markets for some NTFPs are seasonal and may coincide with peak food production periods, when food insecurity is less of an issue. By the time of the next lean season, earlier income surpluses gained by the sale of NTFPs may have been disbursed among household members (Haglund *et al*., 2011). These observations point to the importance of incorporating detailed seasonal and other time-related data into analyses of the extent to which the use of NTFPs form part of coping strategies at the household level.

## BUILDING RESILIENT LANDSCAPES FOR IMPROVING FOOD SECURITY

The analogues between ecological resilience and the role of diversification strategies in food security are obvious: more diverse ecosystems are more resilient to environmental and other shocks. Greater economic diversity in terms of assets that can be used for income and consumption creates households that are more resilient to food insecurity. So the roles of forests and trees in building household resilience and increasing food security come from these two dimensions: enabling more diverse and resilient farming ecosystems, and creating greater economic diversity in terms of assets that can be used for income and consumption.

Forests and trees undoubtedly act as food-security safety nets in times of crisis, especially for the very poor. In the long term, however, the value of forests and trees in this role could diminish if the resource becomes degraded, for example if social and environmental shocks become more frequent. So how can farming ecosystems be made more robust, and how can diversification be used to do this?

There is a clear need to take a broader perspective about how trees and forests are part of rural landscapes. The term "landscape" has permeated recent discussions on rural development (see Rietbergen-McCracken, Maginnis and Sarre, 2007).[3]

[3] This section is derived from Dewees *et al*. (2011).

A landscape is often defined as a geographical construct that includes biophysical features of an area and also, potentially, its cultural and institutional attributes. It describes a mosaic of land-cover and land-use types relevant to the processes or services being considered or managed – a dynamic, complex patchwork of overlapping political, economic, social and ecological systems that are individually relatively homogeneous.

A landscape approach is a conceptual framework that allows a structured view of the broader effects of major interventions in the rural sector. It describes such interventions at a spatial scale that encourages attempts to optimize interactions among a range of land-cover types, institutions and human activities. The ideas of landscape restoration, landscape planning and eco-agriculture all build on landscape approaches and principles.

Trees in landscapes can increase the resilience of food-production systems and therefore household resilience. They can help even out a household's use of seasonal labour and create reserves of capital for new investment, and they can help clarify land tenure. Trees in landscapes can range from contiguous, large tracts of forests used for multiple purposes, to mosaics of forests and blocks and other configurations of trees and agroforestry systems within rural landscapes.

A tree-oriented approach to landscape restoration complements and enriches more narrowly defined approaches to afforestation, reforestation and land and water conservation, with the central aim of improving both human livelihoods and ecological integrity. Among other things, landscape restoration aims to:

- restore a balance of environmental, social and economic benefits from forests and trees within a broader pattern of land use;
- increase the functionality of landscapes and the supply of ecosystem services across the range of land uses, not just maximize new forest cover;
- have an impact on whole landscapes, not just individual sites;
- stimulate grassroots economic development that supports sustainable livelihoods and thus diminishes some of the drivers of landscape degradation and increases resilience;
- involve people as central elements of landscapes and increase their involvement in decision-making.

**Examples of landscape approaches**

Some countries are incorporating landscape strategies as a central part of national development policies. In Rwanda, for example, the Land Husbandry, Water Harvesting and Hillside Irrigation Project, supported by the World Bank, is using a landscape approach to address challenges created by uneven rainfall,

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***A farm and forest landscape in the Kiseny region in northeastern Rwanda. Trees in landscapes can increase the resilience of food-production systems and therefore household resilience***

production variability, small landholdings, limited commercialization and land constraints due to population growth. It is providing infrastructure for land husbandry (e.g. terracing and downstream reservoir protection), water harvesting (e.g. valley dams and reservoirs), and hillside irrigation (e.g piping, fittings and field application for basin and furrow irrigation), all in a manner consistent with the principles of a landscape approach.

In Albania, a project that integrates the management of forests, pastures and agriculture shows that with the strong involvement of local communities, whole landscapes can recover, with dramatic results. Improved forest governance, local management, small-scale investments and managed grazing measures have halted unsustainable land use, thereby reducing carbon emissions and protecting key watersheds. As a result, incomes from forestry and agriculture have increased by 50 percent in targeted microcatchment areas (The World Bank, 2012).

## POLICIES FOR BUILDING RESILIENT LANDSCAPES AND RESILIENT HOUSEHOLDS

Various policy responses have been shown to increase the incorporation of trees and forests in managed landscapes to improve social–ecological resilience. Some of these are described below.

**Policies and institutions can be reoriented to ensure that trees, forests and landscape restoration are addressed.** The devolution of full control over land and other natural resources to local institutions and organizations is increasingly seen as a requirement for bringing about better natural resource management. The challenges are to increase the legitimacy of local management organizations, ensure that these organizations can put in place effective management mechanisms, and see that local organizations have the capacity to limit elite capture. At the same time, centralized government forest authorities, which have tended to resist change, need to be reoriented from their earlier role, which was largely regulatory, towards service delivery aligned with poverty mitigation. Government- and donor-led initiatives must go beyond the forest sector and engage a wide range of public and private stakeholders, including water, agriculture, livestock, energy, land and environmental finance and planning authorities; producer groups; civil-society organizations, including business associations; food companies; and private investors.

**Landscape approaches work better if rights to land and trees are secure.** Secure rights create incentives for individual farmers, households and communities to invest in improved land and water management and protect trees and forests. Appropriate pricing regimes encourage the rational use of scarce resources.

**Improving value adding at the local level can increase incentives for the better management of landscapes and trees in farming systems.** Local value added can be boosted by simplifying the regulatory regime to reduce transaction costs for poor producers and developing a framework to improve support for producer organizations and user groups. Trade associations have shown that they can play a role in promoting market diversification, improving the prospects for niche market entry and establishing product standards.

**Payments for ecosystem services can help.** Markets for ecosystem services from trees and better-managed farming landscapes could be developed more fully. Experience suggests that these types of initiative are most successful when they are integrated with other rural development activities; they can lead to productivity increases and improve climate resilience.

**Policies that improve land, water and tree governance can minimize the risks associated with large-scale land acquisitions.** Large-scale land acquisitions are increasingly a reality in Africa and elsewhere, and present both risks and opportunities. Policies that strengthen access to information and protect existing land rights can help ensure that land transfers are voluntary and beneficial for local people. A sound policy framework can help attract responsible agro-investors and strengthen food security. Legislation that recognizes farmers' rights to the trees on their farms can provide incentives for land restoration and sustainable land management practices.

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## References

**Barany, M., Hammett, A.L., Stadler, K. & Kengni, E.** 2004. Non-timber forest products in the food security and nutrition of smallholders afflicted by HIV/AIDS in sub-Saharan Africa. *Forests, Trees and Livelihoods*, 14: 3–18.

**Bellefontaine, R., Petit, S., Pain-Orcet, M., Deleporte, P. & Bertault, J.G.** 2002. *Trees outside forests: towards better awareness*. FAO Conservation Guides No. 35. Rome, FAO.

**Bucher, E.H. & Huszar, P.C.** 1999. Sustainable management of the Gran Chaco of South America: ecological promise and economic constraints. *Journal of Environmental Management*, 57: 99–108.

**Carpenter, S., Walker, B., Anderies, J.M. & Abel, N.** 2001. From metaphor to measurement: resilience of what to what? *Ecosystems*, 4: 765–781.

**Chidumayo, E.N. & Gumbo, D.J.** 2013. The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. *Energy for Sustainable Development*, 17: 86–94.

**Delacote, P.** 2007. Agricultural expansion, forest products as safety nets, and deforestation.

*Environment and Development Economics*, 12: 235–249.

**Dewees, P., Place, F., Scherr, S. & Buss, C.** 2011. *Investing in trees and landscape restoration in Africa: what, where, and how*. Washington, DC, Program on Forests.

**FAO.** 2005. *Miombo woodlands and HIV/AIDS interactions – Mozambique country report*. Forestry Policy and Institutions Working Paper No. 2. Rome (available at: www.fao.org/docrep/008/j5251e/j5251e00.htm).

**Fisher, M. & Shively, G.E.** 2005. Can income programs reduce tropical forest pressure? Income shocks and forest use in Malawi. *World Development*, 37(7): 1115–1128.

**Haglund, E., Ndjeunga, J., Snook, L. & Pasternak, D.** 2011. Dry land tree management for improved household livelihoods: farmer managed natural regeneration in Niger. *Journal of Environmental Management*, 92: 1696–1705.

**Hegde, R. & Bull, G.** 2008. Economic shocks and Miombo woodland resource use: a household level study in Mozambique. *In*: P. Dewees, ed. *Managing the miombo woodlands of southern Africa* (Technical Annex 4). Washington, DC, The World Bank.

**Hollings, C.S.** 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4: 1–23.

**Hollings, C.S. & Goldberg, M.A.** 1971. Ecology and planning. *Journal of the American Institute of Planners*, 37(4): 221–230.

**Kayambazinthu, D., Barany, M., Mumba, R. & Holding Anyonge, C.** 2005. *Miombo woodlands and HIV/AIDS interactions: Malawi country report*. Forestry Policy and Institutions Working Paper No. 6. Rome, FAO (available at: www.fao.org/docrep/008/j6038e/j6038e00.htm).

**Michon, G., Mary, F. & Bompard, J.** 1986. Multistoried agroforestry garden system in West Sumatra, Indonesia. *Agroforestry Systems*, 4(4): 315–338.

**Mwampanda, T.H., Ghilardi, A., Sander, K. & Chaix, K.J.** 2013. Dispelling common misperceptions to improve attitudes and policy outlook on charcoal in developing countries. *Energy for Sustainable Development*, 17: 75–85.

**Ngaga, Y.M., Munyanziza, E. & Masalu, H.E.** 2006. The role of wild mushrooms in the livelihoods of rural people in Kiwele village, Iringa, Tanzania: implications for policy. *Discovery and Innovation*, 18: 246–251.

**Paumgarten, F.** 2007. *The significance of the safety net role of NTFPs in rural livelihoods, South Africa*. Rhodes University, Grahamstown, South Africa (MSc thesis).

**Ribot, J.C.** 1999. A history of fear: imagining deforestation in the West African dryland forests. *Global Ecology and Biogeography*, 8: 291–300.

**Rietbergen-McCracken, J., Maginnis, S. & Sarre, A.** 2007. *The forest landscape restoration handbook*. London, Earthscan.

**Shackleton, S.E.** 2006. *Forests as safety nets for mitigating the impacts of HIV/AIDS in southern Africa*. Forest Livelihood Brief No. 4. Bogor, Indonesia, Center for International Forestry Research.

**Tairo, V.E.** 2007. The composition and regeneration status of wild food plants in Chenene miombo woodland, Dodoma Rural District, Tanzania. *Discovery and Innovation*, 19: 107–111.

**The World Bank.** 2012. Albania Natural Resources Development Project. Implementation Completion and Results Report (ICR1859). Washington, DC, Europe and Central Asia Department, Sustainable Development Department, The World Bank.

**Volker, M. & Waibe, H.** 2010. Do rural household extract more forest products in times of crisis? Evidence from the mountainous uplands of Vietnam. *Forest Policy and Economics*. DOI:10.1016/j.forpol.2010.03.001.

**Walker, B., Hollings, C.S., Carpenter, S.R. & Kinzing, A.** 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society*, 9(2): 5.

**Wilson, K.B.** 1989. Trees in fields in southern Zimbabwe. *Journal of Southern African Studies*, 15(2): 1–15.

**Wurster, K.W.** 2010. Management matter? Effects of charcoal production management on woodland regeneration in Senegal. PhD thesis, University of Maryland, College Park.

**Zulu, L.C.** 2010. The forbidden fuel: charcoal, urban woodfuel demand and supply dynamics, community forest management and woodfuel policy in Malawi. *Energy Policy*, 38(2010): 3717–3730. ◆

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# The contributions of forest foods to sustainable diets

*B. Vinceti, A. Ickowitz, B. Powell, K. Kehlenbeck, C. Termote, B. Cogill and D. Hunter*

*More research, and greater use of traditional knowledge, will help fulfil the potential of forest foods as a valuable component of nutritious diets.*

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Traditionally, policy-makers have focused on energy-rich staple crops such as wheat, rice and maize in the quest for national and global food security. However, many staple foods contain only low amounts of limiting micronutrients essential for human health and by themselves are insufficient to address the problem of "hidden hunger", or micronutrient deficiency (Pinstrup-Andersen, 2013; Miller and Welch, 2013). The challenge for policy-makers and other stakeholders is to promote food systems that are productive, nutritious, sustainable and culturally acceptable. The ultimate goal is to have a food system that ensures "sustainable diets", defined (in Burlingame and Dernini, 2012) as:

*those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources.*

Figure 1 shows some of the dimensions of sustainable diets. This article examines the contribution that forests and trees can make to some of these dimensions and proposes recommendations for optimizing that contribution.

*Previous page: A woman prepares to transport* Landolphia *spp. fruits (mabongo) to be sold at the market in Yangambi, the Democratic Republic of the Congo. A number of wild indigenous fruit trees in sub-Saharan Africa have high vitamin and mineral contents, and increasing their production and consumption could increase the sustainability of diets in the region*

*Right: Leaves of* Vitex doniana *and powder from baobab leaves (*Adansonia digitata*) at the market in Parakou, Benin*

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## FORESTS AND SUSTAINABLE DIETS

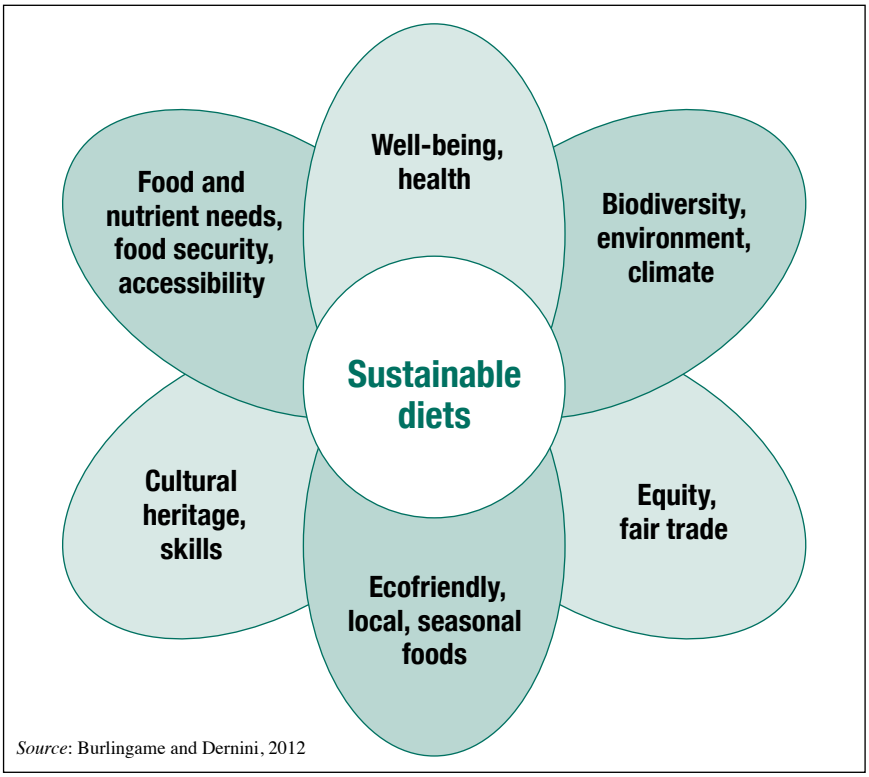
### Use and nutrition of forest foods

Forest foods such as wild fruits, nuts, vegetables, mushrooms and animal products contribute in many ways to food security. While few communities worldwide rely on forest foods to provide their complete diet (Colfer, 2008), forest foods help maintain household nutrition in many communities, especially during lean seasons (complementing, for example, the seasonality of staple agricultural crops), in times of low agricultural production, during periods of climate-induced vulnerability, and when gaps in the availability of food occur due to other cyclical events (Kehlenbeck, Asaah and Jamnadass, 2013).

The dietary quality of many forest foods is high. Many of the micronutrients provided by forest foods have important health and developmental functions, and their absence in diets therefore has important health implications (UNSCN, 2004). For example, vitamin A deficiency causes blindness in up to 500 000 children per year and is also associated with high rates of infection (e.g. diarrhoea, measles and respiratory-tract infections) because of its importance in the functioning of the immune system (Black, Morris and Bryce, 2003). Good dietary sources of vitamin A are green leafy vegetables and orange-coloured fruits and vegetables. Deficiencies in iron, zinc and vitamin $B_{12}$ can impair growth, cognitive development and school performance in children, with lifelong implications for health and socio-economic success (UNSCN, 2004). The best dietary sources of these micronutrients are animal-sourced foods (meat).

Most animal foods, including those sourced from forests, are rich in highly bioavailable[1] iron, zinc and vitamin $B_{12}$ (as well as protein and fat) (Nasi, Taber and Van Vliet, 2011; Murphy and Allen, 2003). Forests also provide diverse options for leafy vegetables, fruits and other plant foods important for the intake of vitamin A, iron, folate, niacin and calcium (Vinceti, Eyzaguirre and Johns, 2008). In one study in the United Republic of Tanzania,

*1*
*The many dimensions of a sustainable diet*




*Source*: Burlingame and Dernini, 2012

[1] The commonly accepted definition of bioavailability is the proportion of a nutrient that is digested, absorbed and metabolized through normal pathways. It is not enough to know how much of a nutrient is present in a dietary supplement; the more important issue is how much of that present is bioavailable.

*A woman prepares gbedegbede (***Amaranthus dubius***), a leafy vegetable harvested in the wild in Kisangani, the Democratic Republic of the Congo. Green leafy vegetables are good dietary sources of vitamin A, an essential micronutrient for human health*

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children who consumed forest foods had more diverse and nutrient-dense diets than those who did not, and there was also greater tree cover in close proximity to their homes (Powell, Hall and Johns, 2011). Another study in the Democratic Republic of the Congo found the consumption of wild plant foods to be associated with a higher intake of vitamin A and calcium (Termote *et al*., 2012).

Even though the nature of much of the available evidence is circumstantial, a growing body of data indicates that increased agricultural and forest biodiversity leads to a more varied diet, which in turn improves human health (Johns and Eyzaguirre, 2006; Johnson, Jacob and Brown, 2013).

***Wildlife resources.*** Wild meat, here defined as non-domesticated terrestrial mammals, birds, reptiles and amphibians harvested in the wild for food, is the main source of animal protein in many tropical forest regions, especially the Congo and Amazon basins (Arnold *et al*., 2011; Nasi, Taber and Van Vliet, 2011). A significant proportion of the wildlife biomass hunted by humans for food across the tropics, especially large-bodied primates, ungulates and rodents (average weight greater than 1 kg), is found in tropical forest ecosystems, with ungulates and sometimes rodents dominating the biomass in more open habitats (Robinson and Bennett, 2004). Edible insects are also important elements in the diet (Ndoye and Tieguhong, 2004; Termote *et al*., 2012; Kuyper, Vitta and Dewey, 2013; van Huis *et al*., 2013).

Animal-based foods supply many important micronutrients in much higher amounts or with higher bioavailability than most plant-based foods (Murphy and Allen, 2003). A recent study in a remote part of the eastern rainforest in Madagascar (where local communities rely heavily on local wildlife resources)

**TABLE 1. Nutrient contents of selected African indigenous and exotic fruits per 100 g edible portion**

| Species | Energy (Kcal) | Protein (g) | Vitamin C (mg) | Vitamin A (RE*) (µg) | Iron (mg) | Calcium (mg) |
|---|---|---|---|---|---|---|
| ***Indigenous fruits*** | | | | | | |
| *Adansonia digitata* L. | 327 | 2.5 | 126–**509** | 0.03–0.06 | 6.2 | 275 |
| *Dacryodes edulis* | 263 | 4.6 | 19 | n.a. | 0.8 | 43 |
| *Grewia tenax* (Forrsk.) Fiori | n.a. | 3.6 | n.a. | n.a. | **7.4–20.8** | **610** |
| *Irvingia gabonensis* (kernels) | 697 | 8.5 | n.a. | n.a. | 3.4 | 120 |
| *Sclerocarya birrea* Hochst. | 225 | 0.7 | 85–**319** | **0.035** | 3.4 | 35 |
| *Tamarindus indica* L. | 275 | **3.6** | 11–20 | 0.01–0.06 | 3.1 | 192 |
| *Ziziphus mauritiana* Lam. | 184 | 0.4 | 3–14 | 0.07 | 0.8 | 23 |
| ***Exotic fruits*** | | | | | | |
| Guava *(Psidium guajava* L.*)* | 68 | 2.6 | **228.3** | 0.031 | 0.3 | 18 |
| Mango *(Mangifera indica* L.*)* | 65 | 0.5 | 27.7 | 0.038 | 0.1 | 10 |
| Orange *(Citrus sinensis* (L.*)* Osbeck) | 47 | 0.9 | 53.0 | 0.008 | 0.1 | 40 |
| Pawpaw *(Carica papaya* L.*)* | 39 | 0.6 | 62.0 | **0.135** | 0.1 | 24 |

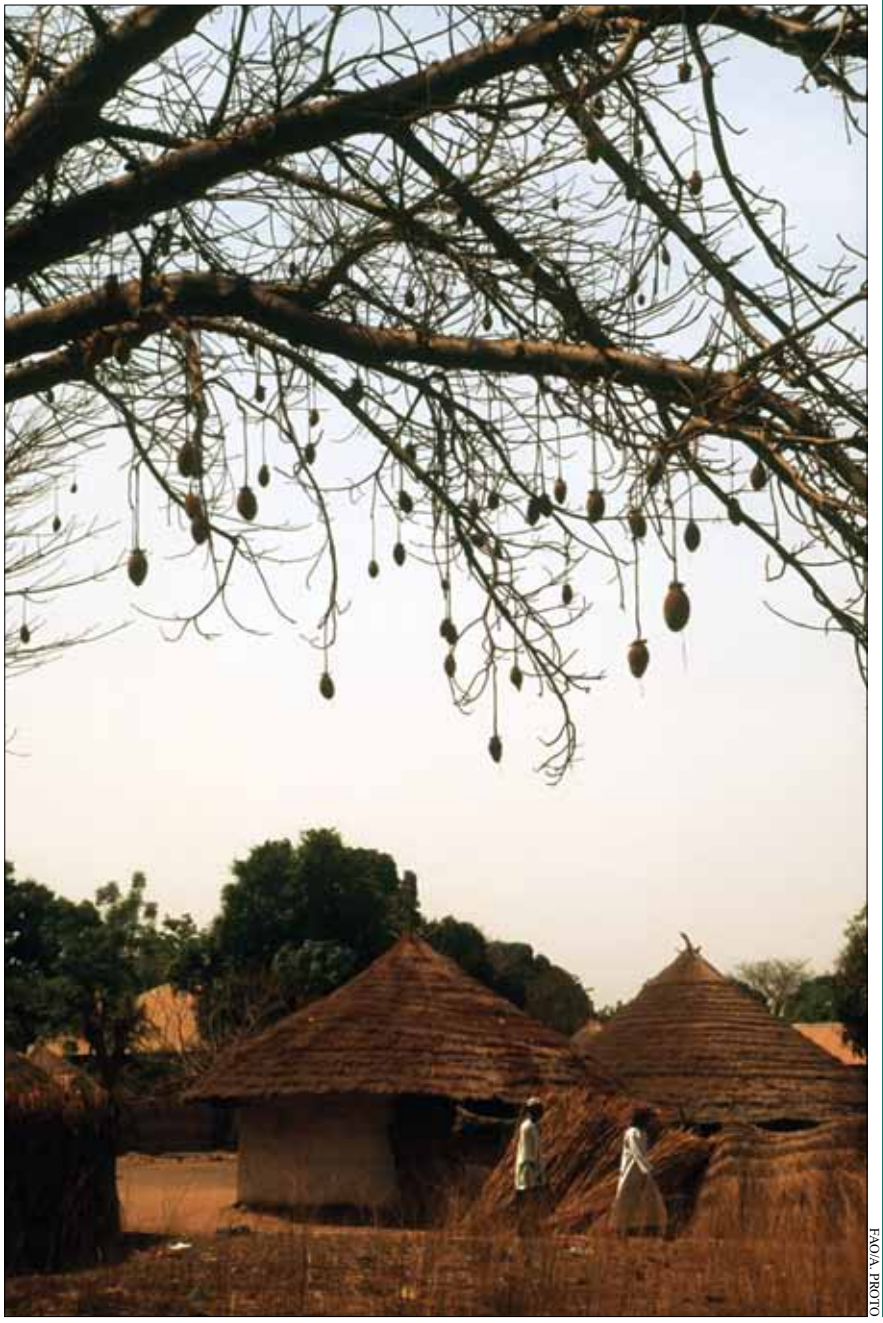
*Notes:* high values are shown in bold. *RE = retinol equivalents.
*Sources:* Kehlenbeck, Asaah and Jamnadass, 2013; Stadlmayr *et al*., 2013

estimated that the loss of wild meat from the diet of children, without substitution by other sources, would result in a 29 percent increase in children suffering from iron-deficiency anaemia (Golden *et al*., 2011).

The overexploitation of certain wild animal populations is leading to the depletion of populations of some species (Nasi, Taber and Van Vliet, 2011). The resultant decline in the availability of wild meat threatens the food security and livelihoods of forest communities (Heywood, 2013), especially those in which home consumption is more common than wild-meat trading.

***Forest fruits in sub-Saharan Africa.*** Fruit consumption in sub-Saharan Africa has been estimated to fall considerably short of the recommended daily amount (Ruel, Minot and Smith, 2005). Kehlenbeck, Asaah and Jamnadass (2013) showed that a number of wild indigenous fruit trees have high vitamin and mineral contents (Table 1), with the potential to contribute year-round to the micronutrient supply of local communities, even during seasons of food shortages. For example, consuming 40–100 g of berries produced by *Grewia tenax* (a widespread, fruit-producing deciduous shrub) could supply almost 100 percent of the daily iron requirement of a child under the age of eight years. In addition to micronutrients, the high sugar content of fruits such as tamarind (*Tamarindus indica*) and baobab (*Adansonia digitata*) make them important sources of energy. The fruits of *Dacryodes edulis* and the seeds of *Irvingia gabonensis*, *Sclerocarya caffra* and *Ricinodendron rautanenii* all have higher fat contents than peanuts (Barany *et al*., 2004).

Until a decade ago, little research had been conducted on the range of intraspecific genetic variation behind the variable nutritive values and other properties of edible products from key tree species. Although data are still sparse, a recent review by Stadlmayr *et al*. (2013) of the nutrient composition of selected indigenous fruits in sub-Saharan Africa noted very high variability in nutrient content among naturally occurring populations of the same species. This offers the opportunity to select individual trees with the highest nutrient contents in their fruits for future domestication programmes. Similar genetic variability has been documented in non-cultivated indigenous vegetables in the United Republic of Tanzania with regard to iron, zinc and β-carotene (Msuya, Mamiro and Weinberger, 2009), and also in cereals (millet, sorghum, rice, wheat and fonio) in Mali analysed for iron, zinc, thiamine, riboflavin and niacin, with ecological and climatic conditions strongly affecting values (Barikmo, Ouattara and Oshaug, 2007).



FAO/A. PROTO

***Fruit of the baobab tree (*Adansonia digitata*) hang ready to harvest near Basse, the Gambia. Baobab fruit are high in vitamin C***

FAO/G. NAPOLITANO

*Berries from a jujube fruit tree (*Ziziphus zizyphus*) in Bangladesh. Jujube is a drought-resistant tree that produces a nutritious fruit that can be eaten fresh or dried. Over many generations, indigenous peoples have developed knowledge systems, practices and decision-making for the identification, preparation and sustainable management of wild foods in forests and on farms*

***Homegardens.*** Seminal work on the domestication of wild tree species was carried out in West Africa in order to boost food supply and cope with food insecurity during conflicts (Okafor, 1976). Domestication programmes are now being developed to bring wild tree species into cultivation and to integrate them into agroforestry systems (Leakey, 2012), including homegardens. Homegardens are common in the tropics and subtropics and can provide readily available, diverse food products and many ecosystem services (Kehlenbeck, Arifin and Maass, 2007). It has been estimated that around 1 billion people in the tropics obtain produce from homegardens supported by semi-subsistence agriculture (Heywood, 2013). Improving homegarden systems can be highly effective in improving micronutrient intake (Masset *et al*., 2012). Some studies have found that a child's nutritional status is associated with the presence of a homegarden and that the garden's biodiversity, rather than its size, is the most important factor (Jones *et al*., 2005).

### Cultural importance of forest foods

A recent extensive review of indigenous food systems around the world, including in many forest regions, highlighted the cultural importance of traditional foods, many of which are wild or semi-domesticated (Kuhnlein, Erasmus and Spigelski, 2009; Kuhnlein *et al*., 2013). Over many generations, indigenous peoples have developed knowledge systems, practices and decision-making for the identification, preparation and sustainable management of wild foods in forests and on farms (Kuhnlein, Erasmus and Spigelski, 2009; Turner *et al*., 2011). In South Africa, most forest foods traded in local markets maintain a prime position in local cultures; in several cases, commercial substitutes for forest foods do not exist, and wild-harvested products are generally preferred even when alternative products can be found (Shackleton, Shanley and Ndoye, 2008).

## CHALLENGES AND OPPORTUNITIES

The concept of sustainable diets is relatively new, and it has not yet been incorporated in forest management approaches. The following challenges must be met to strengthen the contribution of forest foods to sustainable diets.

### Cultural challenges

One of the factors most likely to determine differences in the use and value of forest foods is ethnicity (Termote, Van Damme and Dhed'a Djailo, 2011). Traditional knowledge should therefore be taken into consideration when promoting nutritious forest foods as part of diets and in the selection of priority species for marketing and domestication (Shanley *et al*., 2011). Some indigenous wild foods, especially vegetables, may be perceived as old-fashioned or inferior (Chweya and Eyzaguirre, 1999), yet they can attract premium prices in urban markets (Chelang'a, Obare and Kimenju, 2013). Others, such as wild meat in parts of Africa, bestow cultural prestige (Lindsey *et al*., 2013).

The availability of and access to forest foods may decline due to physical shortages of the product as a consequence of deforestation, forest degradation and overexploitation, among other reasons. In many countries, changes in livelihood strategies, the processes of urbanization and globalization, and changes in diets have resulted in considerable changes in the consumption of indigenous wild foods (Pingali, 2007).

Research has shown that as former hunter–gatherer groups, such as the Baka and Kola Pygmies of Cameroon and the Tubu Punan of Borneo, became sedentary, they suffered many negative dietary, nutritional and epidemiological consequences (Dounias and Froment, 2011). Around the world, forest-based communities are abandoning traditional lifestyles and food regimes in exchange for diets higher in processed foods, salt, refined sugar and fat – a shift referred to as the nutrition transition (Popkin, 2004).

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*"Soumbala" produced from seeds of* **Parkia biglobosa***, sold in a local market in Parakou, Benin. The availability of and access to forest foods may decline as a consequence of deforestation, forest degradation and overexploitation*

**Sustainability of use of forest foods**

Several threats could affect the capacity of forests and other tree-based systems to provide food and nutrients. The unsustainable harvesting of wild species has been documented in various contexts (Sundriyal and Sundriyal, 2004; Delvaux, Sinsin and Van Damme, 2010). It is increasingly accepted that the commercialization of non-wood forest products frequently leads to overharvesting and declining availability in the absence of sustainable forest management (Belcher, Ruiz-Perez and Achdiawan, 2005). A review of important fruit species in the local economy and diet near Iquitos, Peru, revealed that the availability of several of the most popular wild-harvested fruit species had decreased markedly (Vasquez and Gentry, 1989).

Subsets of species, usually referred to as "conflict-of-use" species, are valued for both wood and non-wood forest products (Guariguata *et al*., 2010). Research on the rates of extraction (for timber) of species that are valued locally for medicinal and food use (e.g. *Dipteryx odorata*, *Parahancornia fasciculata* and *Endopleura uchi*) carried out in logging frontiers in the Amazon Basin indicated that logging contributes to declining access (Shanley, 2012). Other reports have shown that 5 of the 12 most valuable fruit and medicinal species traded in eastern Amazonia are also valued timber species (Serra *et al*., 2010). In Cameroon, timber harvesting targets species that have edible fruits and oils; others host caterpillars that, at a certain time of the year, comprise 75 percent of the protein consumed by Baka Pygmies (Ndoye and Tieguhong, 2004). Conflicts between multiple uses have also been documented in Asia (Limberg *et al*., 2007). In West Africa, selected multipurpose trees that supply food, wood and medicines are maintained when woodland is cleared for traditional agriculture (Faye *et al*., 2010). However, useful trees and shrubs are now disappearing due to shortening fallow periods, conflicts over tenure, a drying climate, overbrowsing by livestock, and the absence of management practices to protect regeneration (Maranz, 2009).

For most wild-collected animal and plant species, little is known about the effects of harvesting on genetic diversity and the long-term survival of populations (for example, Sunderland, Besong and Ayeni, 2002, on *Gnetum* spp.). Detailed inventories of these wild species exist for only a few countries and species, and the literature is scattered.

**The rise of food-based approaches**

The overall health outcomes of a diet rich in multiple micronutrients and phytochemical and other components of food that regulate physiological functions are being increasingly recognized (Miller and Welch, 2013). This has led to a shift in focus in nutrition interventions towards improving overall dietary patterns and quality by increasing dietary diversity – defined as the number of unique foods or food categories consumed in a given period – and promoting the consumption of foods naturally rich in micronutrients or enriched through fortification[2] (Torheim *et al*., 2010; Fanzo *et al*., 2013).

Forest foods can play an important role in such interventions. The increasing focus on dietary diversity as an indicator of food security and a proxy for diet quality allows a quick, user-friendly, low-cost assessment of the whole diet (Kennedy, Ballard and Dop, 2011). Translating the findings into programmes is challenging, however, and researchers are investigating the best tools for evaluating diversity in diets and the nutritional outcomes (Ruel, 2003; Arimond *et al*., 2010; Masset *et al*., 2012). Many

[2] According to the definition used by the World Health Organization and FAO, fortification refers to the practice of deliberately increasing the content of essential micronutrients (i.e. vitamins and minerals, including trace elements) in a food, irrespective of whether the nutrients were originally in the food before processing, to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.

interacting factors affect the content and bioavailability of micronutrients in human diets and there is a need to adopt a food-system approach that includes all the steps from forest/farm to plate, examining all aspects affecting the nutritional outcomes of a particular diet, from agricultural production systems to food-processing methods and consumer education strategies (Miller and Welch, 2013).

There is growing interest in the use of micronutrient-rich foods, including wild plant and animal foods, to supplement the diets of children who predominantly consume staple foods (Kuyper, Vitta and Dewey, 2013). Based on local availability and ease of access, underused complementary foods may be affordable and potentially more acceptable than some other options. An example is the fermented condiment known as *soumbala* obtained from the seeds of *Parkia biglobosa*, a west African tree species. A rich source of iron, *soumbala* is often used by families as a low-cost substitute for meat (Savadogo *et al*., 2011).

**Increasing knowledge**

Bringing about a change in attitude towards the consumption of traditional foods is a challenge because they are often considered inferior (see van Huis *et al*., 2013, for edible insects). Improved scientific knowledge of nutritional values, and greater documentation of indigenous knowledge, could lead to more conducive policies and a change in attitude towards forest foods (Kuhnlein, Erasmus and Spigelski, 2009; Kuhnlein *et al*., 2013).

In some cases, the consumption of micronutrient-rich foods has increased as a result of information dissemination and promotion, but nutrition interventions remain complicated by a lack of data on the nutrient content of lesser-known species and limited understanding of the dietary requirements for many micronutrients. There are also challenges in measuring habitual food intake due to the difficulty that study participants have in recalling exactly what they have eaten over a certain period of time, and also self-report bias, where participants tend to under-report behaviours they think researchers will consider inappropriate. The generation and use of better data on the nutrient composition of forest foods should be combined with research on ecology, management and (participatory) domestication so that appropriate, nutritionally rich species can be integrated into fields and homegardens (Pudasaini *et al*., 2013).

**Adapting management of forests and trees to account for forest foods**

Many traditional communities actively manage the wild resources they use. Where there is conflict over the use of multi-purpose species that supply both timber and food products, forest management plans should be negotiated with timber companies and adapted to consider the interests of both local communities and timber companies (Ndoye and Tieguhong, 2004). Such an approach should be based on sound cost–benefit analyses that take into account the nutritional and cultural importance of forest foods in the diets of the most vulnerable: women and children.

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***Women in Parakou, Benin, gather for a focus group discussion about the food tree species commonly used in the diet during food shortage periods***

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*In Gulmi in western Nepal, a socially marginalized family poses in their homegarden, which is an essential source of nutritious foods, including several derived from trees. Homegardens are key elements in rural landscapes; they are important reservoirs of agricultural biodiversity and of the knowledge to make use of it, and they can also help empower women. Better approaches are needed to manage heterogeneous landscapes for nutrition-sensitive food-production systems*

Women have a central role in ensuring food security and adequate nutrition (de Schutter, 2011), and interventions directed towards women are likely to have a particularly beneficial impact (Hoddinott, 1999). Supporting the role of women as producers and consumers of food would help remove barriers to improved nutrition, including the increased consumption of forest foods. A process led by FAO that reviewed guidance documents developed by several international organizations found that empowering women is a key principle in better linking agriculture and nutrition (Herforth, 2013).

Maintaining forest cover near villages and homes may be necessary if forest foods are to retain their place in diets. Nutritionally important indigenous trees can also be introduced to farming systems to produce traditional forest foods through processes of domestication that improve product quality and yield.

**Access to forest foods**

A lack of secure access rights and land tenure discourages many poor and marginalized communities from investing in more productive and sustainable land management and from protecting and planting key tree-food species. In many countries, local control and management of forests is still constrained by weak political and institutional arrangements and a lack of access by the poor to resources that can yield forest foods and income. Policies and programmes that enable local people to have a genuine role in decision-making are rare (Larson and Ribot, 2007).

**Integrating forest biodiversity into complex landscapes**

Landscape approaches can help reconcile conservation and development objectives (Sayer *et al*., 2013). In many places, fallow land and farm bushland areas are managed actively to protect and regenerate species that are valued by local communities. In the Brazilian Amazon, primary forests were found to sustainably provide more wild meat per unit area than secondary forests (Parry, Barlow and Peres, 2009), whereas the density of useful plant species was lower in mature forests than in secondary forests in the Bolivian Amazon (Toledo and Salick, 2006). In the Peruvian Amazon, Gavin (2004) found that fallow provided fewer useful species than secondary forest, but the total monetary value of the items obtained from fallow was higher. In the mixed landscapes of western Panama, Smith (2005) found that each land use made a unique contribution to providing access to different species of wild meat, highlighting the importance of diversified landscape approaches in both research and conservation.

**RECOMMENDATIONS**

To help optimize the role of forests and trees in sustainable diets, we recommend that policy-makers, land-use planners and land managers:

- seek innovative approaches to the management of heterogeneous landscapes to ensure that food-production systems are nutrition-sensitive, while minimizing their ecological footprint;
- prioritize research into and the development of nutritious forest foods, including the documentation and integration of indigenous knowledge, the analysis and documentation of the nutritional composition, digestibility and bioavailability of forest foods, the effect of storage and processing on the nutritional value of specific forest foods, and the potential for the domestication of important forest species and their integration into farming systems and product value chains;

- encourage research that examines the relative contribution of forest foods to local diets and nutrition;
- support research on governance and access to forests and forest products;
- support the development of nutrition-sensitive product value chains involving forest foods;
- study the ecological impacts and sustainability of harvesting the various forest species for food;
- ensure that extension services, schools, hospitals and health centres are aware of the benefits of, and promote, the consumption of nutritious forest foods in their programmes and interventions;
- promote the better integration of information and knowledge on nutritious forest foods and their conservation into national nutrition strategies and programmes by establishing policy platforms that bring together the environment, health, development, agriculture, forestry and other sectors with the aim of mainstreaming the use of forest foods in strategies addressing food security, nutrition, conservation and land-use planning and related policies.

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## References

**Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A., Daniels, M.C., Deitchler, M., Fanou-Fogny, N., Joseph, M.L., Kennedy, G., Martin-Prevel, Y. & Torheim, L.E.** 2010. Simple food group diversity indicators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. *Journal of Nutrition*, 140(11): 2059S–2069S.

**Arnold, M., Powell, B., Shanley, P. & Sundernald, T.C.H.** 2011. Forests, biodiversity and food security. *International Forestry Review,* 13(3): 259–264.

**Barany, M., Hammett, A.L., Stadler, K.M. & Kengni, E.** 2004. Non-timber forest products in the food security and nutrition of smallholders afflicted by HIV/AIDS in sub-Saharan Africa. *Forests, Trees and Livelihoods*, 14: 3–18.

**Barikmo, I., Ouattara, F. & Oshaug, A.** 2007. Differences in micronutrients content found in cereals from various parts of Mali. *Journal of Food Composition and Analysis*, 20(8): 681–687.

**Belcher, B., Ruiz-Perez, M. & Achdiawan, R.** 2005. Global patterns and trends in the use and management of commercial NTFPs: implications for livelihoods and conservation. *World Development*, 33(9): 1435–1452.

**Black, R.E., Morris, S.S. & Bryce, J.** 2003. Where and why are 10 million children dying every year? (Child survival). *The Lancet*, 361.9376: 2226.

**Burlingame, B. & Dernini, S.** eds. 2012. *Sustainable diets and biodiversity*. Rome, FAO and Bioversity International.

**Chelang'a, P.K., Obare, G. & Kimenju, S.C.** 2013. Analysis of urban consumers' willingness to pay a premium for African leafy vegetables (ALVs) in Kenya: a case of Eldoret Town. *Food Security*, 5(4): 591–595.

**Chweya, J.A. & Eyzaguirre, P.B.** 1999. *The biodiversity of traditional leafy vegetables*. Rome, International Plant Genetic Resources Institute.

**Colfer, C.J.P.** 2008. *Human health and forests: global overview of issues, practice and policy*. London, Earthscan.

**Delvaux, C., Sinsin, B. & Van Damme, P.** 2010. Impact of season, stem diameter and intensity of debarking on survival and bark re-growth pattern of medicinal tree species, Benin, West Africa. *Biological Conservation*, 143: 2664–2671.

**de Schutter, O.** 2011. *Report submitted by the UN Special Rapporteur on the Right to Food: UN General Assembly Human Rights Council* (available at: www.srfood.org/index.php/en/component/content/article/1-latest-news/1174-report-agroecology-and-the-right-to- food).

**Dounias, E. & Froment, A.** 2011. From foraging to farming among present-day forest hunter-gatherers: consequences on diet and health. *International Forestry Review*, 13(3): 338–354.

**Fanzo, J., Hunter, D., Borelli, T. & Mattei, F.** eds. 2013. *Diversifying food and diets: using agricultural biodiversity to improve nutrition and health*. London, Earthscan.

**Faye, M.D., Weber, J.C., Abasse, T.A., Boureima, M., Larwanou, M., Bationo, A.B., Diallo, B.O, Sigué, H., Dakouo, J.M., Samaké, O. & Sonogo Diaité, D.** 2010. Farmers' preferences for tree functions and species in the West African Sahel. *Forests, Trees and Livelihoods*, 20(2–3): 113–136.

**Gavin, M.C.** 2004. Changes in forest use value through ecological succession and their implications for land management in the Peruvian Amazon. *Conservation Biology*, 18(6): 1562–1570.

**Golden, C.D., Fernald, L.C.H., Brashares, J.S., Rasolofoniaina, B.J.R. & Kremen, C.** 2011. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proceedings of the National Academy of Sciences of the United States of America*, 108(49): 19653–19656. DOI:10.1073/pnas.1112586108.

**Guariguata, M.R., Garcia-Fernandez, C., Sheil, D., Nasi, R., Herrero-Jáuregui, C., Cronkleton, P. & Ingram, V.** 2010. Compatibility of timber and non-timber forest product management in natural tropical forests: perspectives, challenges, and opportunities. *Forest Ecology and Management*, 259: 237–245.

**Herforth, A.** 2013. *Synthesis of guiding principles on agriculture for nutrition*. Rome, FAO (available at: www.fao.org/fileadmin/user_upload/wa_workshop/docs/Synthesis_of_Ag-Nutr_Guidance_FAO_IssuePaper_Draft.pdf).

**Heywood, V.** 2013. Overview of agricultural biodiversity and its contribution to nutrition and health. *In* J. Fanzo, D. Hunter, T. Borelli & F. Mattei, eds. *Diversifying food and diets: using agricultural biodiversity to improve nutrition and health issues in agricultural biodiversity*, pp. 35–67. London, Earthscan.

**Hoddinott, J.** 1999. *Operationalizing household food security in development projects: an introduction*. Washington DC, International Food Policy Research Institute.

**Johns, T. & Eyzaguirre, P.B.** 2006. Linking biodiversity, diet and health in policy and practice. Symposium on "wild-gathered plants: basic nutrition, health and survival". Linking biodiversity, diet and health in policy and practice. *Proceedings of the Nutrition Society*, 65: 182–189.

**Johnson, K.B., Jacob, A. & Brown, M.E.** 2013. Forest cover associated with improved child health and nutrition: evidence from the Malawi Demographic and Health Survey and satellite data. *Global Health: Science and Practice*, 1(2): 237–248.

**Jones, K.M., Specio, S.E., Shrestha, P., Brown, K.H. & Allen, L.H.** 2005. Nutrition knowledge and practices, and consumption of vitamin a rich plants by rural Nepali participants and nonparticipants in a kitchen-garden program. *Food and Nutrition Bulletin*, 26(2): 198–208.

**Kehlenbeck, K., Arifin, H.S. & Maass, B.L.** 2007. Plant diversity in homegardens in a socio-economic and agro-ecological context. *In* T. Tscharntke, C. Leuschner, M. Zeller, E. Guhardja & A. Bidin, eds. *The stability of tropical rainforest margins: linking ecological, economic and social constraints of land use and conservation*, pp. 297–319. Berlin, Springer.

**Kehlenbeck, K., Asaah, E. & Jamnadass, R.** 2013. Diversity of indigenous fruit trees and their contribution to nutrition and livelihoods in sub-Saharan Africa: examples from Kenya and Cameroon. *In* J. Fanzo, D. Hunter, T. Borelli & F. Mattei, eds. *Diversifying food and diets: using agricultural biodiversity to improve nutrition and health issues in agricultural biodiversity*, pp. 257–269. London, Earthscan.

**Kennedy, G., Ballard, T. & Dop, M.C.** 2011. *Guidelines for measuring household and individual dietary diversity*. Rome, FAO.

**Kuhnlein, H., Erasmus, B., Spigelski, D. & Burlingame, B.** eds. 2013. *Indigenous Peoples' food systems and well-being: interventions and policies for healthy communities*. Rome, FAO and Montreal, Canada, Centre for Indigenous Peoples' Nutrition and Environment.

**Kuhnlein, H.V.** 2009. Introduction: why are Indigenous Peoples' food systems important and why do they need documentation? *In* H.V. Kuhnlein, B. Erasmus & D. Spigelski, eds. *Indigenous peoples' food systems: the many dimensions of culture, diversity and environment for nutrition and health*, pp. 1–7. Rome, FAO and Montreal, Canada, Centre for Indigenous Peoples' Nutrition and Environment.

**Kuhnlein, H.V., Erasmus, B. & Spigelski, D.** 2009. *Indigenous peoples' food systems: the many dimensions of culture, diversity and environment for nutrition and health*. Rome, FAO and Montreal, Canada, Centre for Indigenous Peoples' Nutrition and Environment (available at www.fao.org/docrep/012/i0370e/i0370e00.htm).

**Kuyper, E., Vitta, B. & Dewey, K.** 2013. Novel and underused food sources of key nutrients for complementary feeding. *Alive&Thrive Technical Brief*, Issue 6 (available at www.aliveandthrive.org).

**Larson, A.M. & Ribot, J.C.** 2007. The poverty of forestry policy: double standards on an uneven playing field. *Sustainability Science*, 2(2).

**Leakey, R.R.B.** 2012. *Living with the trees of life: towards the transformation of tropical agriculture*. Wallingford, UK, CABI.

**Limberg, G.R., Iwan, M., Moeliono, M., Sudana, I.M. & Wollenberg, E.** 2007. Community-based forestry and management planning. *In* P. Gunarso, T. Setyawati, T. Sunderland & C. Shackleton, eds. *Managing forest resources in a decentralized environment: lessons learnt from the Malinau Research Forest, East Kalimantan, Indonesia*. Bogor, Indonesia, Center for International Forestry Research.

**Lindsey, P.A., Balme, G., Becker, M., Begg, C., Bento, C., Bocchino, C. & Zisadza-Gandiwa, P.** 2013. The bushmeat trade in African savannas: impacts, drivers, and possible solutions. *Biological Conservation*, 160: 80–96.

**Maranz, S.** 2009. Tree mortality in the African Sahel indicates an anthropogenic ecosystem displaced by climate change. *Journal of Biogeography*, 36: 1181–1193.

**Masset, E., Haddad, L., Cornelius, A. & Isaza-Castro, J.** 2012. Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. *British Medical Journal*, 344: d8222. DOI:10.1136/bmj.d8222.

**Miller, B.D.D. & Welch, R.M.** 2013. Food system strategies for preventing micronutrient malnutrition. *Food Policy*. http://dx.doi.org/10.1016/j.foodpol.2013.06.008.

**Msuya, J.M., Mamiro, P. & Weinberger, K.** 2009. Iron, zinc and β-carotene nutrient potential of non-cultivated indigenous vegetables in Tanzania. *Acta Horticulturae (ISHS)*, 806: 217–222.

**Murphy, S.P. & Allen, L.A.** 2003. Nutritional importance of animal source foods. *Journal of Nutrition*, 133: 3932S–35S.

**Nasi, R., Taber, A. & Van Vliet, N.** 2011. Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. *International Forestry Review*, 13(3): 355–368.

**Ndoye, O. & Tieguhong, J.C.** 2004. Forest resources and rural livelihoods: the conflict between timber and non-timber forest products in the Congo Basin. *Scandinavian Journal of Forest Research*, 19(sup004): 36–44. DOI:10.1080/14004080410034047.

**Okafor, J.C.** 1976. Development of forest treecrops for food supplies in Nigeria. *Forest Ecology and Management*, 1: 235–247.

**Parry, L., Barlow, J. & Peres, C.A.** 2009. Hunting for sustainability in tropical secondary forests. *Conservation Biology*, 23(5): 1270–1280.

**Pingali, P.** 2007. Westernization of Asian diets and the transformation of food systems: implications for research and policy. *Food Policy*, 32(3): 281–298.

**Pinstrup-Andersen, P.** 2013. Can agriculture meet future nutrition challenges? *European Journal of Development Research*, 25: 5–12.

**Popkin, B.M.** 2004. The nutrition transition: an overview of world patterns of change. *Nutrition Reviews*, 62(7Pt 2): S140–143.

**Powell, B., Hall, J. & Johns, T.** 2011. Forest cover, use and dietary intake in the East Usambara Mountains, Tanzania. *International Forestry Review*, 13(3): 305–324.

**Pudasaini, R., Sthapit, S., Suwal, R. & Sthapit, B.** 2013. The role of integrated home gardens and local, neglected and underutilized plant species in food security in Nepal and meeting the Millennium Development Goal 1 (MDG). *In* J. Fanzo, D. Hunter, T. Borelli & F. Mattei, eds. *Diversifying food and diets: using agricultural biodiversity to improve nutrition and health issues in agricultural biodiversity*, pp. 242–256. London, Earthscan.

**Robinson, J.G. & Bennett, E.L.** 2004. Having your wildlife and eating it too: an analysis of hunting sustainability across tropical ecosystems. *Animal Conservation*, 7: 397–408.

**Ruel, M.T.** 2003. Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. *Food and Nutrition Bulletin*, 24(2): 231–232.

**Ruel, M.T., Minot, N. & Smith, L.** 2005. *Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multi-country comparison*. Presentation made at the FAO/WHO Workshop on Fruit and Vegetables for Health, Kobe, Japan.

**Savadogo, A., Iboudu, J.A., Gnankine, O. & Traore, A.S.** 2011. Numeration and identification of thermotolerant endospore-forming *Bacillus* from two fermented condiments Bikalga and Soumbala. *Advances in Environmental Biology*, 5: 2960–2966.

**Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.-L., Sheil, D., Meijaard, E. & Buck, L.E.** 2013. Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences of the United States of America*, 110(21): 8349–8356.

**Serra, M., Shanley, P., Melo, T., Fantini, A., Medina, G. & Viera, P.** 2010. From the forest to the consumer: the ecology, local management and trade of *Amapá amargoso, Parahancornia fasciculata* (Poir) Benoist in the state of Pará. *In* U.P. Albuquerque & N. Hanazaki, eds. *Recent developments and case studies in ethnobotany*, pp. 213–231. Recife, Brazil, Sociedade Brasileira de Etnobiologia. Núcleo de Publicações em Ecologia e Etnobotânica Aplicada.

**Shackleton S., Shanley, P. & Ndoye, O.** 2008. Invisible but viable: recognising local markets for non-timber forest products. *International Forestry Review*, 9(3): 697–712.

**Shanley, P., Cymerys, M., Serra, M. & Medina, G.** 2011. *Fruit trees and useful plants in Amazonian life*. Rome, FAO, Bogor, Indonesia, Center for International Forestry Research and Bristol, USA, People and Plants International.

**Shanley, P., Silva, S., Melo, T., Carmenta, R. & Nasi, R.** 2012. From conflict of use to multiple use: forest management innovations by small holders in Amazonian logging frontiers. *Forest Ecology and Management*, 268: 70–80.

**Smith, D.A.** 2005. Garden game: shifting cultivation, indigenous hunting and wildlife ecology in western Panama. *Human Ecology*, 33(4): 505–537.

**Stadlmayr, B., Charrondiere, R., Eisenwagen, S., Jamnadass, R. & Kehlenbeck, K.** 2013. Nutrient composition of selected indigenous fruits from sub-Saharan Africa. *Journal of the Science of Food and Agriculture*, 93: 2627–2636.

**Sunderland, T.C.H., Besong, S. & Ayeni, J.S.O.** 2002. *Distribution, utilization and sustainability of the non-timber forest products of the Takamanda Forest Reserve, Cameroon*. Consultancy Report for the Project Protection of the Forests Around Akwaya. Mamfe, Cameroon, GTZ.

**Sundriyal, M. & Sundriyal, R.C.** 2004. Wild edible plants of the Sikkim Himalaya: marketing, value addition and implications for management. *Economic Botany*, 58(2): 300–315.

**Termote, C., Bwama Meyi, M., Dhed'a Djailo, B., Huybregts, L., Lachat, C., Kolsteren, P. & Van Damme, P.** 2012. A biodiverse rich environment does not contribute to a better diet: a case study from DR Congo. *PloS ONE*, 7(1): e30533. DOI:10.1371/journal.pone.0030533

**Termote, C., Van Damme, P. & Dhed'a Djailo, B.** 2011. Eating from the wild: Turumbu, Mbole and Bali traditional knowledge on non-cultivated edible plants, District Tshopo, DRCongo. *Genetic Resources and Crop Evolution*, 58(4): 585–618. DOI:10.1007/s10722-010-9602-4.

**Toledo, M. & Salick, J.** 2006. Secondary succession and indigenous management in semideciduous forest fallows of the Amazon Basin. *Biotropica*, 38(2): 161–170.

**Torheim, L.E., Ferguson, E.L., Penrose, K. & Arimond, M.** 2010. Women in resource-poor settings are at risk of inadequate intakes of multiple micronutrients. *Journal of Nutrition*, 140: 2051S–2058S.

**Turner, N.J., Łuczaj, Ł.J., Migliorini, P., Pieroni, A., Dreon, A.L., Sacchetti, L.E. & Paoletti, M.G.** 2011. Edible and tended wild plants, traditional ecological knowledge and agroecology. *Critical Reviews in Plant Sciences*, 30(1–2): 198–225.

**UNSCN.** 2004. *Fifth report on the world nutrition situation*. Geneva, Switzerland, United Nations Standing Committee on Nutrition and International Food Policy Research Institute.

**van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G. & Vantomme, P.** 2013. *Edible insects: future prospects for food and feed security*. FAO Forestry Paper No. 171. Rome, FAO.

**Vasquez, R. & Gentry, A.H.** 1989. Use and misuse of forest-harvested fruits in the Iquitos area. *Conservation Biology*, 3: 350–61.

**Vinceti, B., Eyzaguirre, P. & Johns, T.** 2008. The nutritional role of forest plant foods for rural communities. *In* C.J.P. Colfer, ed. *Human health and forests: a global overview of issues, practice and policy,* pp. 63–96. London, Earthscan. ◆

FAO/G. NAPOLITANO

*Participants attend the opening session of the International Conference on Forests for Food Security and Nutrition at FAO headquarters in Rome, Italy*

# Forests and trees outside forests are essential for global food security and nutrition

*Summary of the International Conference on Forests for Food Security and Nutrition*

FAO headquarters, Rome, Italy, 13–15 May 2013

The International Conference on Forests for Food Security and Nutrition was organized by FAO in partnership with Bioversity International, the Center for International Forestry Research, the World Agroforestry Centre and the World Bank.[1] This technical meeting was attended by more than 400 participants, comprising experts from governments, civil-society organizations, indigenous and other local communities, donors and international organizations in more than 100 countries, who made a wide range of important points, many of which are summarized below.

This summary and the recommendations therein were developed by the conference organizers and do not necessarily represent the position of the member states of FAO.

[1] The conference was sponsored by the Department for International Development of Great Britain and Northern Ireland, the German Federal Ministry of Food, Agriculture and Consumer Protection, the Norwegian Ministry of Agriculture and Food, the United States Forest Service, the World Agroforestry Centre and the World Bank.

## KEY MESSAGES

- The role of forests and trees outside forests[2] in the fight against hunger demands much greater attention and should be integrated with strategies for food security and nutrition.
- Food security is grounded in diversity – in terms of biota, landscapes, cultures, diets, production units and management. Forests and trees are critical for maintaining that diversity.
- The ecosystem services provided by forests and trees make essential contributions to forest-dependent communities and agriculture by, among other things, protecting soil and water, maintaining soil fertility, regulating the climate, and providing habitat for wild pollinators and the predators of agricultural pests.

[2] As used in this summary, the term "trees outside forests" encompasses agroforestry systems, other trees on farms, and trees in non-forested rural and urban landscapes.

**KEY MESSAGES** (continued)

- Forest foods and tree products have been important components of rural diets for millennia and today provide essential nutrition for millions of people. More than one-third of the world's people rely on woodfuel for cooking.
- Forests, trees outside forests and the sustainable management of these resources are crucial for ensuring the resilience of food-production systems in the face of climate change and economic, social and political instability. Forest- and tree-based sources of income can contribute to building resilience.
- There are opportunities to use more forest species, especially plants and insects, for the large-scale production of food products. However, deforestation and forest degradation risks the loss of many such species.
- The single biggest cause of forest loss is agricultural expansion, but there is potential for both increasing agricultural production and protecting forests, including through the restoration of degraded forest land, the greater use of trees in agriculture, and the alignment of policies and institutional frameworks to that end.
- Secure land and forest tenure and more equitable access to resources for local communities and women will encourage sustainable forest- and tree-based approaches to food security and nutrition.
- There is a need to retrieve, document and make better use of traditional knowledge and to combine it with scientific knowledge to increase the role of forests and trees outside forests in food security and nutrition.
- Women often have specialized knowledge of forests and trees in terms of species diversity, uses for various purposes, and conservation and sustainable management practices, but the role of women in ensuring the food security and nutrition of forest-dependent communities is underappreciated.
- Greater collaboration at the national and international levels is needed to improve data collection on, and the communication, reporting and monitoring of, the contributions of non-wood forest products, forest ecosystem services and other forest- and tree-related aspects of food security and nutrition.
- Training in the management of sustainable forest enterprises can help forest-dependent communities, particularly women and youth, to gain access to equitable value chains, such as those applied in fair trade, thereby improving the food security and nutrition of such communities and helping them to capitalize on their traditional knowledge.
- Governments, civil society, indigenous peoples, bilateral and multilateral development assistance agencies, the private sector and other stakeholders are invited to strengthen the contributions of forests and trees outside forests to food security and nutrition through a number of feasible actions, listed in the recommendations below.

FAO/R. FAIDUTTI

***A woman in Guinea walks past a mature* Parinari excа*, an evergreen forest tree with rough-skinned, edible fruit. Globally, many millions of people depend on forests and trees outside forests for their food security and nutrition through the consumption and sale of foods harvested from forests and trees outside forests and through forest-related employment, forest ecosystem services, and forest-based biodiversity***

## THE BENEFITS OF FORESTS, TREES OUTSIDE FORESTS AND AGROFORESTRY

Globally, millions of people depend on forests and trees outside forests for their food security and nutrition – directly through the consumption and sale of foods harvested from forests and trees outside forests, and indirectly through forest-related employment, forest ecosystem services, and forest-based biodiversity.

Forest foods and tree products, such as leaves, seeds, nuts, honey, fruits, mushrooms, insects and game animals, have been important components of rural diets for millennia. The wide range of medicinal plants found in forests contributes to the health and

FAO/A.VITALE

*Fishermen in Nagapattinum, Tamil Nadu, India, sit on an upturned boat after the 2005 tsunami. There is strong evidence that forests help protect coastal areas from flooding, thereby increasing the stability of food production on coastal lands, and they also act as sources of employment and provide food in the wake of such disasters*

well-being of forest-dependent people and forms the basis of many pharmaceutical products now produced globally. Forests and trees outside forests are important sources of fodder for livestock, especially in drylands. The genetic diversity in natural forests offers huge potential for the discovery, development and improvement of new sources of food and medicine, among others.

There is enormous potential to use more forest species, including plants and insects, for the large-scale production of foods. Many forest foods and tree products have extremely high nutritional value.

The ecosystem services provided by forests and trees outside forests make important contributions to agricultural production and forest-dependent communities, such as by protecting water and soil resources, contributing to soil development processes, increasing soil fertility, regulating climate and providing habitat for wild pollinators and agricultural pest predators.

Forested wetlands and mangrove forests help protect coastal areas from flooding, thereby increasing the stability of food production on coastal lands. Forests also play vital roles in riverine and coastal fisheries, which are often particularly important in poor communities. Mountain forests perform essential ecosystem services, such as the provision of high-quality water for downstream communities and their agricultural activities.

Forests and trees outside forests are important sources of food and income, especially for the poor and women, and may be key in times of economic, political or ecological crisis. The presence of forests and trees outside forests increases ecosystem resilience and the capacity of people to meet their nutritional needs.

An estimated 2.6 billion people rely on woodfuel, including charcoal, for cooking. The use of wood as a source of energy is vital for local economies and for maximizing the palatability and nutritional value of foods that require cooking.

A wide range of agroforestry systems, including agrosylvipastoral systems, is available to support food security and nutrition through the direct provision of food, by raising farmer incomes and providing fuel for cooking, by improving soils and thereby increasing agricultural productivity, and through the provision of other ecosystem services.

Indigenous peoples and other local communities hold an immense wealth of traditional knowledge on the cultivation, harvesting and preparation of forest foods and tree products and on sustainable land management. Traditional forest–agriculture landscapes tend to have high resilience in the face of environmental and social perturbations.

FAO/S.MAINA

***Beekeepers near Kigoma, the United Republic of Tanzania, harvest honeycomb from a hive. Forest foods and tree products, such as honey, have been important components of rural diets for millennia***

## KEY CHALLENGES AND BOTTLENECKS

The many contributions of forests and trees outside forests to food security and nutrition are usually poorly reflected in national development, agricultural, and food security and nutrition strategies, and there is often a lack of long-term funding to ensure the success of projects to promote sustainable forest management and agroforestry. Many land-use planning strategies, often developed without the participation of affected people, and large-scale agriculture investments, have undermined smallholder farmers by excluding them from emerging value chains, inadvertently creating competition for resources, and limiting the capacity of smallholders to cope with climatic risk, pests, and the uncertainty of market demand. Globally, agriculture is the main cause of forest loss.

In many places, forest foods and tree products are being overharvested. For example, the overexploitation of wild meat is a serious issue in some forests in Africa. Poorly implemented land-use actions associated with, for example, unsustainable logging, mining and agriculture can have cumulative effects that cause the impoverishment of land and local communities. Land and forest degradation contributes to food insecurity and is associated with increased rates of child mortality. As people become more food insecure, their capacity to innovate is hindered, further exacerbating their food insecurity. Those who are food insecure are more likely to deplete and mine natural resources unsustainably.

If the technology is inefficient, the use of wood for cooking can cause severe health problems related to indoor air pollution and may also generate significant greenhouse gas emissions. In the absence of proper management and distribution systems, the collection of fuelwood can be a disproportionately high burden for women and children, but it can also be an important source of income. In some areas, the harvesting of wood for energy is a major driver of forest degradation.

Agricultural practices should take into account the economic, social and environmental pillars of sustainable development. The environmental costs of agricultural practices are often ignored. Along with unbalanced subsidies, this can make agriculture more profitable than the sustainable management of forests and agroforestry systems but can lead to unsustainable agricultural practices.

Research is lacking on forest biodiversity with potential importance for food security and nutrition. Moreover, there is a risk that traditional knowledge of forest foods will be lost, or will be exploited by outsiders who obtain most of the commercial benefits of this knowledge. Local traditional knowledge is often ignored in conventional approaches to land-use planning, development and management, which tend to reduce biodiversity and lead to a corresponding loss of resilience.

There is a lack of knowledge and data to support effective policy-making on (among others): the role of non-wood forest products (NWFPs), wildlife and forest ecosystem services in food security and nutrition and the realization of the right to food; labour and decent employment in the forest sector, especially the NWFP subsector; the role of forests and trees in urban food security and nutrition; mountain forests and their role in food security and nutrition; and the socio-economic circumstances of forest-dependent people. Moreover, there is no internationally agreed framework (or formats) to guide the collection, reporting and dissemination of data on the use and trade of NWFPs, wildlife and forest ecosystem services important for food security and nutrition.

Women often have specialized knowledge of forests and trees in terms of their species diversity, uses for various purposes, and management and conservation. Compared with men, women's knowledge tends to be linked more directly to household food consumption and health and is particularly important during food crises. However, the role of women in forestry value chains is often poorly supported by policy-makers and service providers.

## POLICY OPTIONS, PRACTICAL INNOVATIONS AND EMERGING OPPORTUNITIES

The potential economic, social and environmental gains from secure land tenure are substantial and can lead to fundamental improvements in land management. The recent endorsement of the Voluntary Guidelines for the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security by the Committee on World Food Security, coupled with the Voluntary Guidelines to Support

FAO/FO-0264/T. HOFER

***Steep agricultural fields in a highly degraded landscape in southwest China. Deforestation and unsustainable land management can have cumulative effects that cause the impoverishment of land and local communities***

FAO/R. FAIDUTTI

***Workers in Indonesia harvest rice. A landscape approach to management with a strong ecological basis can increase the capacity of people to produce, harvest and buy food in the face of social, economic and environmental shocks and stresses***

the Progressive Realization of the Right to Adequate Food in the Context of National Food Security, provide a basis for progress in this area.

Sustainable forest management is a broad and evolving concept for ensuring the sustainable use and conservation of forests while generating benefits for local people, including increased food security and nutrition.

A landscape approach to natural resource management that addresses the economic, social and environmental pillars of sustainable development can help ensure the sustainable management of forests and trees outside forests in a broader context. Such a systematic approach with a strong ecological basis can increase the capacity of people to produce, harvest and buy food in the face of social, economic and environmental shocks and stresses. This focus on resilience can contribute to the long-term achievement of food security. The active participation of all stakeholders, including the economically marginalized and socially excluded, in sustainable land management, benefit-sharing and decision-making is crucial.

Policies that improve rights of use and access to land, forests and trees could create significant incentives for small-scale farmers to adopt agroforestry systems and ensure the recognition of agroforestry as an investment option. Investments that support smallholder agroforestry ventures in marketing their products and ecosystem services, including through fair-trade initiatives, are yielding encouraging results for both investors and producers. Microfinance loans to small and medium-sized forest enterprises have been shown to lead to rises in family incomes in rural areas and to increases in health, nutrition and quality of life, especially when such microloans are made to women. In many cases, producer associations designed to meet the needs of smallholders and marginalized and excluded people have had a significant impact on improving livelihoods. The Committee on World Food Security is developing principles for responsible agricultural investments in the context of food security and nutrition.

REDD+ initiatives can help in the recognition of the forest rights of indigenous peoples and other local communities, although income from such initiatives has not yet proved sufficient to sustain forests financially. Initiatives to promote sustainable development and food security and nutrition through sustainable forest management and the introduction of trees and shrubs and by supporting farmer-managed natural regeneration are also promising. In a number of countries, schemes to share forest-related revenues more equitably are improving the food security and nutrition of the poor.

Decent employment in forestry is an important means of improving food security and nutrition for people who rely on forests for their livelihoods. A sustainable approach would look at creating more high-skill jobs in the forest sector and upgrading existing ones to increase income and productivity and make working conditions safer and more stable. This, in turn, will help improve the availability of, access to and consumption of food in terms of calories, and increase the quality of food in terms of variety, diversity, nutrient content and safety. Small and medium-sized forest enterprises and community-based forest management have huge potential to provide employment in forest communities and can be especially important for women.

Strong rural institutions can help ensure the contribution of forests and trees outside forests to the food security and nutrition of rural communities. The commitment and capacity of governments to engage openly with rural communities is required.

FAO/A. CONTI

***This wooded area in the communally owned and managed* Ejido Canalejas de Otates *in Mexico contains useful timber and provides shelter and fodder for livestock. Broad, intersectoral partnerships are needed to promote the sustainable use of forests and trees outside forests by rural communities to contribute to the achievement of food security and nutrition***

**RECOMMENDATIONS**

Governments, civil society, indigenous peoples, bilateral and multilateral development assistance agencies, the private sector and other stakeholders are invited to strengthen the contributions of forests and trees outside forests to food security and nutrition by:

1. Participating in broad partnerships to promote the sustainable use of forests and trees outside forests by rural communities to contribute to the achievement of food security and nutrition.
2. Ameliorating conditions that currently keep forest-dependent people in low-status and low-productivity jobs.
3. Providing access to resources by indigenous peoples and other local communities and marginalized people by, for example, applying the Voluntary Guidelines for the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security.
4. Creating, as appropriate, and strengthening rural community-based institutions and increasing social dialogue and representation with the aim, among other things, of improving access to knowledge, finance, markets, better prices and technologies for local people and their equitable involvement in decision-making and recognizing the rights, roles and responsibilities of communities as stewards and beneficiaries of forests and wildlife.
5. Eliminating all forms of discrimination in forests and promoting equal opportunities for youth, women and men and the protection of the rights of indigenous peoples and other local communities, including the right to free, prior and informed consent and the right to territory.
6. Reviewing all relevant laws, policies and actions so that they uphold the food-related rights set out in the Universal Declaration of Human Rights, the Covenant on Economic, Social and Cultural Rights and other relevant treaties and documents, and so that, among other things, they: do not violate the right to food; protect citizens from such violations; provide mechanisms to ensure that marginalized and excluded forest-dependent communities have access to justice if such violations occur; and provide for concrete possibilities to enable people to feed themselves, including through the use of forests and trees.
7. Protecting forests and seeking ways in which agricultural production can be expanded without the loss or degradation of forests, such as through the restoration of degraded forest lands and the greater use of trees outside forests as a means of intensifying agricultural productivity.
8. Taking an integrated approach to food security and nutrition so that relevant sectoral policies, including those on agriculture, forests, trees, wildlife and food security and nutrition, have well-defined objectives, targets and time frames for their implementation and are coordinated intersectorally, and that all stakeholders, from forest-dependent communities to all relevant ministries, are involved actively in their development, implementation and monitoring.
9. Encouraging spatial land-use planning that takes into account the many important roles of forests and trees outside forests in food security and nutrition.
10. Encouraging intersectoral cooperation to promote the sustainable management of forests and trees outside forests at the landscape scale, include forests and trees outside forests in resilience strategies, and investigate the lessons from sustainable forest management that could be applied to achieve sustainability at the landscape scale.
11. Supporting sustainable wildlife management as a source of food with scientific, technical and traditional knowledge, balancing the economic, social and environmental values of wildlife for present and future generations.
12. Increasing opportunities for green jobs and improving conditions for forest workers, especially the most vulnerable, and integrating decent employment concerns in forest and other natural resource policies and programmes.
13. Encouraging the development of markets for forest ecosystem services, such as the provision of clean drinking water and other innovative financing mechanisms to support the role of forests and trees outside forests in food security and nutrition.

14. Promoting long-term investments in forests and trees outside forests to build resilience so that food aid is less necessary.
15. Training institutional staff on gender issues, involving women in monitoring, reporting and verification activities, and developing a gender-sensitive intersectoral global roadmap for forests and trees outside forests.
16. Making better use of traditional knowledge about natural resource management and working with local stakeholders to improve the management of wild forest foods to ensure their sustainability.
17. Increasing the efficiency of biomass-based cooking systems through integrated approaches that take into account both the woodfuel production chain and the woodfuel conversion chain.
18. Supporting the development of entrepreneurial, financial and planning skills among small-scale forest producers to encourage their participation in, and maximize the remuneration they receive from, market-oriented activities in agroforestry, tree-growing, NWFPs, small-scale wood processing and the provision of ecosystem services.
19. Supporting the development of producer associations to assist them to gain access to markets and receive equitable benefits from forests, including through local added value.
20. Collaborating nationally and internationally to improve data collection, reporting and monitoring of NWFPs, forest ecosystem services, forest wildlife and other forest-related aspects of food security and nutrition.
21. Encouraging research that supports the sustainable use of wild forest species of plants, as well as insects and other animals, to improve yields and increase the sustainability of food production.
22. Establishing transparent and inclusive platforms for the dissemination and exchange of knowledge and experiences and to build awareness of the importance of NWFPs and forest ecosystem services, the socio-economic circumstances of forest-dependent people, and the role of forests and trees outside forests in food security and nutrition, with a strong emphasis on robust data.
23. Creating incentives for greater collaboration between scientific disciplines, government sectors and rural institutions to synthesize scientific data and traditional knowledge on the role of forests and trees outside forests in food security and nutrition.
24. Supporting efforts and investments to communicate knowledge on the role of forests and trees outside forests in food security and nutrition in accessible, compelling formats to key stakeholders, including civil society, rural institutions, scientists and policy-makers.
25. Recognizing and celebrating the cultural value, emotional connection and public appeal of forest foods and tree products to rural and urban communities with a view to leveraging political will and public support for practices and policies that support the sustainable management of these resources and their contributions to food security and nutrition.
26. Developing indicators, tools and methods of data collection for food security and nutrition that incorporate forests and trees outside forests and the concerns of women and youth, and develop the necessary capacity.
27. Developing safeguard mechanisms to ensure that the full impacts of forest conversion and other activities such as mining on food security and nutrition are taken into account.

Conference participants encouraged all stakeholders to use this summary to attract greater attention to the role of forests and trees outside forests in food security and nutrition. They further encouraged the FAO Forestry Department to present this summary to the Committee on World Food Security and the Committee on Forestry, and to other important fora, including the Second International Conference on Nutrition (ICN2) to be held at FAO headquarters in Rome on 19–21 November 2014. ◆

## What policy-makers need to do

**FAO has developed a brief for policy-makers based on this conference summary and other outcomes of the International Conference on Forests for Food Security and Nutrition. The brief makes the following five strategic recommendations:**

- **Provide secure land and forest tenure and equitable access to resources by applying the principles outlined in the Voluntary Guidelines for the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security.**
- **Develop mechanisms for coordination across the agricultural, forestry, livestock, fisheries, energy, mining and other relevant sectors to ensure stronger coherence of food security and nutrition interventions and better policy alignment.**
- **Promote policies that increase access by smallholders to credit, technology, extension services and insurance, as well as to markets for their forest and tree products and ecosystem services.**
- **Achieve gender equality in the formulation, implementation and evaluation of food-security, nutrition and poverty-alleviation policies and investment strategies.**
- **Strengthen mechanisms for the collection and timely dissemination of data on the contribution of forests and trees to food security and nutrition for use in policy-making.**

***Towards food security and improved nutrition: increasing the contribution of forests and trees*, a brief for policy-makers, can be downloaded at www.fao.org/forestry/food-security/en/.**

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***Researchers tend seedlings in a greenhouse at the Indian Council for Forestry Research Institute, Dehradun, India. A new global action plan aims to conserve the genetic diversity of the estimated 80 000–100 000 tree species worldwide***

## FAO members adopt first global action plan for forest genetic resources

There are an estimated 80 000–100 000 tree species worldwide. Forests and trees outside forests provide essential ecosystem services, such as the protection of water catchments and soil and carbon sequestration, and they also produce important foods and other products. The capacity of humanity to meet the present and future challenges of food security, poverty alleviation and sustainable development depends in large part, therefore, on the continued availability of the rich diversity between and within tree species. Genetic diversity is needed to ensure that forest trees can survive, adapt and evolve under changing environmental conditions, such as those brought about by climate change.

Genetic diversity is also needed for selection, breeding and domestication programmes for the development of adapted varieties or to strengthen useful traits. In many countries, the prospects for sustainable development in rural areas will be greatly influenced by the state of diversity in forest ecosystems and species.

The Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources, the first of its kind in the forest sector, was adopted by the FAO Conference in June 2013. The Global Plan was prepared based on needs and priorities identified in regional consultations and reports submitted by member countries for the first edition of *State of the world's forest genetic resources*, which will be released by FAO in 2014. FAO's Commission on Genetic Resources for Food and Agriculture has asked the Organization to develop an implementation strategy for the Global Plan and to ensure the mobilization of adequate financial resources for its implementation, particularly in support of developing countries.

The main aims of the Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources are to:

- strengthen understanding and knowledge of forest genetic resources;
- promote the sustainable use and management of forest genetic resources;
- develop and strengthen *in situ* and *ex situ* forest genetic resource conservation programmes through collaboration at the national, regional and global levels;

- promote access to, and the sharing of, information on forest genetic resources at the regional and national levels;
- create and strengthen national programmes to increase regional and international cooperation, including in research, education and training on the use and sustainable management of forest genetic resources, and enhance institutional capacity;
- assist countries, as appropriate, to integrate forest genetic resource conservation and management needs into wider national policies and programmes and frameworks of action at the national, regional and global levels;
- promote the assessment of traditional knowledge, innovations and practices related to forest genetic resources, the equitable sharing of benefits arising from their use, the recognition of their roles, and, where appropriate, the putting in place of effective policies and legislation addressing these matters;
- promote adequate access to, and use of, quality forest reproductive material to support research and development programmes at the national and regional levels and in line with international laws and regulations regarding intellectual property;
- promote ecosystem and ecoregional approaches as efficient means of promoting the sustainable use and management of forest genetic resources;
- assist countries and institutions responsible for the management of forest genetic resources to establish, implement and regularly review national priorities for the sustainable use and management of forest genetic resources;
- strengthen national programmes and enhance institutional capacity – particularly in developing countries and countries with economies in transition – and develop relevant regional and international programmes. Such programmes should include education, research and training to address the characterization, inventory, monitoring, conservation, development and sustainable use of forest genetic resources.

A total of 27 strategic priorities at the international, regional and national levels are identified in the Global Plan, grouped into the following four areas:

- improving the availability of, and access to, information on forest genetic resources;
- the conservation of forest genetic resources (*in situ* and *ex situ*);
- the sustainable use, development and management of forest genetic resources;
- policies, institutions and capacity-building.

*For more information go to: www.fao.org/forestry/fgr/64582/en/.*

## Latin American and Caribbean Forestry Commission

The 28th Session of the Latin American and Caribbean Forestry Commission was convened in Georgetown, Guyana, on 9–13 September 2013. It was attended by delegates from 21 member countries and the representatives of seven international, intergovernmental and non-governmental organizations. The session was opened by His Excellency, Mr Donald Ramotar, President of Guyana.

The Commission considered, and made recommendations on, a range of topics, including FAO's sustainable forest management

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***Delegates pose during the 28th session of the Latin American and Caribbean Forestry Commission***

toolbox, which is under development, the FAO Fire Management Umbrella Programme, the state and conservation of the world's forest genetic resources, voluntary guidelines on national forest monitoring, incentive mechanisms for the protection of natural forests, such as payments for ecosystem services, and follow-up to the conclusions of the International Conference on Forests for Food Security and Nutrition.

The Commission formulated regional priorities for consideration by FAO's Committee on Forestry (COFO) and recommendations for the attention of the 33rd FAO Regional Conference for Latin America and the Caribbean. It expressed support for FAO's new Strategic Framework, which promotes an intersectoral working approach, highlighting the role of forests in the five Strategic Objectives.

The Commission recommended that COFO promote the revision and strengthening of public forest policies so that forest management can be better integrated with national development processes seeking to achieve food security and social well-being. The Commission also recommended that COFO promote the appropriate governance of forest resources, including land and forest tenure, and support the development of mechanisms for the valorization and recognition of ecosystem services for the benefit of those owning or managing forests. All this should be done while promoting the appropriate incorporation and recognition of the economic importance of the forest resource in national accounts.

The Commission recommended that the Regional Conference for Latin America and the Caribbean stress among its member countries the contribution of forests to reducing poverty and food security, improving and protecting livelihoods, and guaranteeing sustainable, productive agrosilvipastoral systems. The Commission reinforced the importance of forest ecosystem services for the development of the agricultural and livestock sectors.

The Commission recommended that the Regional Conference consider that food security depends on a strengthened forest sector, given that forests, trees and forest genetic resources play important roles in achieving strong and resilient agricultural and livestock sectors. It further recommended that the Regional Conference promote national-level institutional efforts to develop intersectoral development policies and agendas, which should encompass forest, environmental, agricultural and livestock issues in a holistic approach to promoting food security and economic development and reducing rural poverty.

The Commission recommended that the Regional Conference, working at the international level, foster action to strengthen intergovernmental organizations carrying out technical cooperation in the forest sector, with a view to promoting sustainable forest management for the benefit of food security and poverty reduction. It specifically requested that FAO be strengthened so that it can continue to work with the countries of the region on forest issues in the context of the Organization's new Strategic Objectives.

Meeting during the session, the Commission's four Subregional Groups (Caribbean, Mesoamerica, Amazon and Southern Cone) discussed and prepared their work plans for the period 2014–2015.

*For more information go to: www.rlc.fao.org/en/events/28-session-of-the-lacfc/.*

## African Forestry and Wildlife Commission wants sustainable development goal on forests

One of the main outcomes of the Rio+20 Conference, held in 2012, was the agreement by countries to launch a process to develop a set of Sustainable Development Goals, which will build on the Millennium Development Goals and converge with the post-2015 development agenda.

At its 19th session, held at Windhoek, Namibia, on 30 September to 4 October 2013, the African Forestry and Wildlife Commission "strongly recommended a standalone forest Sustainable Development Goal that takes into account the achievements and inadequacies of the Millennium Development Goals and related processes". The Commission requested its Chair to submit this recommendation to the Open Working Group process on the development of the Sustainable Development Goals, including through the G-77 and China; encouraged its members to convey the recommendation through their representatives in the Open Working Group; and invited other forestry and related bodies on the African continent and other regions of the world to support the implementation of the recommendation.

*A report on other outcomes of the African Forest and Wildlife Commission meeting will appear in the next edition of* Unasylva.

CATIE

*Participants listen to an address at the Third IUFRO Latin American Congress*

## Third IUFRO Latin American Congress

This event, held on 12–15 June 2013 in San José, Costa Rica, had 600 participants, comprising scientists, decision-makers, professionals, students, community leaders and forest managers and owners, and featured 300 scientific papers presented in 53 technical sessions. The Congress produced the following key messages:

- Latin America needs a stronger and more permanent discussion about forests, especially with a view to sustainable development and the importance of forests on a global scale.
- In Latin America, forests face major challenges related to deforestation (with record highs in the region), degradation, climate change, poverty and food security. Further challenges are the loss of genetic resources and the loss of irreplaceable social and cultural attributes.
- These problems call for technical, economic, social and political solutions. Therefore, it is necessary to improve the science base for decision-making. This does not mean that there is insufficient science but that its messages are not being transmitted well.
- Statistics (the major reference figures at the global, regional and national levels) that are used in the discourse urgently need to be adapted. Year after year, figures are being used for which the origin is often unknown, as is the case with the number of forest-dependent people and the rate of species' extinctions.
- There are clear examples of countries that have managed to achieve substantive objectives by creating a strong base of renewable natural resources, especially forests, which has facilitated development (e.g. Republic of Korea, Finland, Costa Rica and Chile). This is the result of long-term government policies.
- The landscape approach is gaining in importance and coincides with the Millennium Ecosystem Assessment concept of the adaptive mosaic and also with another topic of worldwide priority – human security as a basis for building socio-ecological systems.
- Although bidirectional, the landscape approach should be bottom-up rather than top-down, with local governance at the centre of landscape organization.
- The landscape vision has become stronger at both the global and regional levels, as demonstrated by concepts such as adaptive watershed management, biological corridors,

model forests and other actions that add to less-integrated land management methods. They can be summed up in the concept of climate-smart landscapes. This is a way of giving an analytical framework to progress towards the integration of landscapes in an adaptive-mosaic strategy.

- In view of evident climate-change, there are challenges in providing wood and non-wood forest products and meeting growing demands for these products, which are considered carbon-positive, and their consumption will therefore continue to rise, as will the profitability of management actions related to forests and trees.
- Forest management and wood production in natural forests took a prominent position in Congress presentations. This shows that sustainable forest management is being recognized as an excellent way of conservation. In the region, however, there are considerable discrepancies between "rules on paper" and "rules in use"; governance tends to stick to the philosophy of "command and control", which implies high transaction costs.
- The Congress demonstrated that the challenges facing forests and landscapes have transboundary effects. It has also become evident that a large quantity of scientific knowledge is available in the region. More than ever, however, scientists need to become involved in networking across disciplines and borders. The Congress therefore highlighted the role of networking organizations such as the International Union of Forest Research Organizations (IUFRO) and *Centro Agronómico Tropical de Investigación y Enseñanza* (CATIE).

Congress organizers produced "guidance for action" based on keynote speeches and the 300 presented papers. For the conference summary, including the guidance for action, go to www.iufro.org/download/file/9793/3684/iufrolat3-resolutions_pdf/.

# BOOKS

## Managing forests for climate change

*Climate change guidelines for forest managers*. FAO 2013. FAO Forestry Paper No. 172. Rome. ISBN 978-92-5-107831-0 (print), E-ISBN 978-92-5-107832-7 (PDF).

The effects of climate change and climate variability on forest ecosystems are evident around the world and further impacts are unavoidable, at least in the short to medium term. Addressing the challenges posed by climate change will require adjustments to forest policies, management plans and practices.

These guidelines have been prepared to assist forest managers to better assess and respond to climate-change challenges and opportunities at the forest management unit level. The actions they propose are relevant to all kinds of forest manager – such as individual forest owners, private forest enterprises, public-sector agencies, indigenous groups and community forest organizations. They are applicable in all forest types and regions and for all management objectives.

Forest managers will find guidance on the issues they should consider in assessing climate-change vulnerability, risk and mitigation options, and a set of actions they can undertake to help adapt to and mitigate climate change. Forest managers will also find advice on the additional monitoring and evaluation they may need to undertake in their forests in the face of climate change.

This document complements a set of guidelines prepared by FAO in 2010 to support policy-makers in integrating climate-change concerns into new or existing forest policies and national forest programmes.

*Also available online: http://www.fao.org/docrep/018/i3383e/i3383e00.htm.*

## More than timber in tropical forests

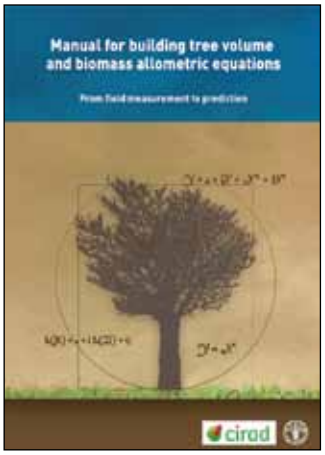
*Multiple-use forest management in the humid tropics: opportunities and challenges for sustainable forest management*. C. Sabogal, M.R. Guariguata, J. Broadhead, G. Lescuyer, S. Savilaakso, N. Essoungou & P. Sist. 2013. FAO Forestry Paper No. 173. Rome, FAO, and Bogor, Indonesia, Center for International Forestry Research. ISBN 978-92-5-107823-5 (print), E-ISBN 978-92-5-107824-2 (PDF).

The multiple-value nature of forests has long been appreciated and used by forest-dependent people in the tropics. Explicitly managing for some or all of these values – multiple-use forest management – is stipulated in the laws of many countries, but its formal implementation in the tropics is thought to be rare.

This paper reports on three regional assessments carried out to identify and draw lessons from on-the-ground initiatives in multiple-use forest management in the Amazon Basin, the Congo Basin and Southeast Asia. In all three regions, information was collected through interviews with country-based forestry experts, forest managers and technicians. A complementary, Web-based questionnaire further examined the reasons for the successes and failures of multiple-use forest management initiatives.

The paper concludes that forest managers need more support if they are to realize the potential of multiple-use forest management. Greater effort is needed to eliminate unfair competition from operators whose sole objective is to extract timber with little or no concern for multiple uses. In most countries, the demarcation of a permanent forest estate and development of national land-use plans would increase investment in multiple-use forest management. Improving the value of logged-over forest through silviculture would also increase the uptake of multiple-use approaches.

*Also available online: http://www.fao.org/docrep/018/i3378e/i3378e00.htm.*




## Improving the accuracy of forest carbon stocks

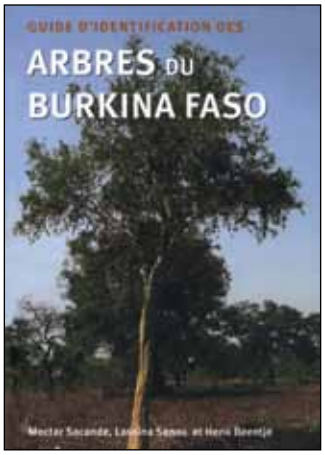
*Manual for building tree volume and biomass allometric equations: from field measurement to prediction*. N. Picard, L. Saint-André & M. Henry 2012. Rome, FAO, and Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Montpellier, France.

Under the United Nations Framework Convention on Climate Change, the benefits to accrue to non-Annex I parties will be based on results that must be measured, reported and verified. The precision of these results, therefore, has a major impact on potential financial compensation. The capacity to measure forest carbon stocks is of increasing importance for countries that plan to contribute to mitigating climate change through their forest activities.

Whatever the method used to measure carbon stocks, including remote sensing, ultimately trees must be measured in the field. Measurements of trees in the field enable the development of allometric equations, which can predict tree biomass from easy-to-measure dendrometric characteristics such as tree diameter and height (which may be obtained remotely). Allometric equations, therefore, are key factors in estimating the contribution made by forest ecosystems to the carbon cycle.

This manual covers all the steps in the construction of allometric equations, starting with the measurement of tree biomass in the field. It should therefore prove particularly useful in countries that are not yet in possession of measurements and equations that match their forests. It takes the form of a guide intended for students, technicians and researchers working to assess forest parameters such as volume, biomass and carbon stocks for commercial, bioenergy or climate-change mitigation purposes.

*Also available online: http://foris.fao.org/static/allometric/Manual_EN_WEB.pdf.*




## Native trees in Burkina Faso

*Guide d'identification des arbres du Burkina Faso*. M. Sacande, L. Sanou & H. Beentje. 2012. 280 pages. Royal Botanic Gardens Kew, London, Kew Publishing. ISBN 978-1-84246-470-0.

This book is a product of the Millennium Seed Bank Partnership, which has worked for a decade to collect and conserve, in duplicates, seeds of more than 1 100 native plant species in Burkina Faso. To address a lack of knowledge of the region's rich flora, this field guide identifies 250 native tree species and provides valuable information on their habitats and distribution in Africa and elsewhere, their uses and physiology, the germination of their seeds, and their conservation status. The brief botanical descriptions, keys, local names and more than 500 fascinating photographs will help specialists and non-specialists to identify each species.

All these species are important for ecosystem functioning and most provide food, feed, energy, timber, traditional medicines, pesticides and insecticides, or are suitable for use as ornamentals. The information provided on seed germination and propagation techniques is aimed at helping the cultivation of these native trees, which grow readily in local conditions without the need for irrigation, fertilizers or pesticides. The guide also paves the way for the use of these tree species in habitat restoration. *Guide d'identification des arbres du Burkina Faso* is a useful document for a wide range of people, such as foresters, park managers, agronomists, horticulturists, environmentalists, tourists, teachers and students.

## Surviving global economic turmoil

*Riding out the storm: improving resilience of the tropical timber sector to the impacts of global and regional economic and financial crises.* F. Maplesden, A. Attah, I. Tomaselli & N. Wong. ITTO Technical Series No. 41. Yokohama, Japan, International Tropical Timber Organization.

Consumer and producer member countries of the International Tropical Timber Organization (ITTO) were severely affected by the global financial and economic crisis that stemmed from the United States subprime mortgage crisis in 2007. The crisis triggered a plunge in housing starts and consumer demand for wood products in traditional markets, resulting in cancelled orders, depressed prices and a severe rationalization of the tropical timber processing industries in producer and consumer countries. The short-term impacts of the crisis included: difficulty among producer countries in accessing capital, a key source of growth, as domestic stimulus packages began to compete for global finance; a decline in foreign direct investment; a reduction in exports by ITTO producer countries as imports by developed countries fell; increased competition for export markets; an end to the recent commodity price boom; increased unemployment, particularly in emerging country export sectors; and reduced spending on research and development.

This report was produced in response to concerns expressed by ITTO producer member countries that the global financial and economic crisis had exposed the vulnerability and lack of preparedness of the tropical timber sector to manage future global and regional economic crises. It draws on a broad knowledge base and experiences in producer and consumer countries in addition to other wood and non-wood industries, and it recommends a number of measures to be adopted by ITTO, ITTO member countries, regional organizations and forest industry and trade associations to support the tropical timber sector's resilience to global economic shocks.

*Also available online: www.itto.int/direct/topics/topics_pdf_download/topics_id=3351&no=1&disp=inline.*

An overview of current knowledge about the impacts of forest management certification
A proposed framework for its evaluation

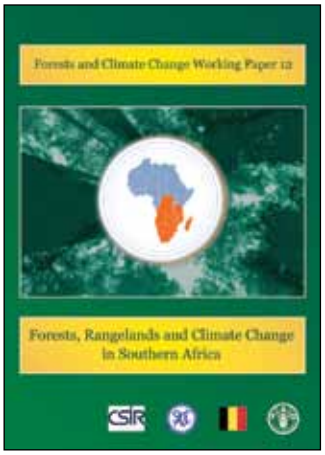
## Evaluating certification

*An overview of current knowledge about the impacts of forest management certification: a proposed framework for its evaluation.* C. Romero, F.E. Putz, M.R. Guariguata, E.O. Sills, P.O. Cerutti & G. Lescuyer. 2013. Occasional Paper No. 91. Bogor, Indonesia, Center for International Forestry Research.

The often-claimed environmental and social benefits of forest certification remain to be empirically evaluated. Virtually all of the numerous publications on the impacts of tropical forest certification are based on secondary sources of information and not on field-based measurements.

This paper proposes an empirical research framework for a carefully designed field-based evaluation of the ecological, social, economic and political impacts of tropical forest management certification, taking into account location-specific contextual factors that shape certification outcomes. The paper suggests that solid methodological quantitative and qualitative approaches be used to build proper counterfactuals on which to base the comparisons for inferring impacts, all informed by a thorough theory of change and through processes that bring stakeholders together. The proposed research framework is a first step towards the design and future implementation of evaluation research in the context of tropical forest certification on a global basis. It is hoped that the proposed research framework will help in learning from past mistakes, building on lessons learned and improving decision-making towards the maintenance of forest values over the long term, for the benefit of society as a whole.

*Also available online: www.cifor.org/online-library/browse/view-publication/publication/4188.html.*




## Climate change in southern Africa

*Forests, rangelands and climate change in southern Africa*. S. Naidoo, C. Davis, & E. Archer van Garderen. 2013. Forests and Climate Change Working Paper No. 12. Rome, FAO.

Forests and rangelands are vital for rural communities in southern Africa but they are under threat from climate change and other pressures. While many climate-change efforts under way in the forest sector in southern Africa are focusing on mitigation, countries recognize the urgent need to build resilience and facilitate adaptation in the sector.

*Forests, rangelands and climate change in southern Africa* investigates the implications of climate change for forests and rangelands in southern Africa, including their vulnerabilities and adaptation needs and options. Combined with an analysis of the economic and social roles of forests and rangelands and the drivers of change, this publication lays the foundation for stronger collaboration in this area among countries in southern Africa.

This publication is part of an initiative by FAO, in cooperation with the Southern African Development Community, on forests, rangelands and climate-change adaptation in southern Africa. The initiative was launched at a workshop in Johannesburg, South Africa, in June 2013 to take stock of countries' current efforts in this area, identify country priorities and potential areas of cooperative work, and define the scope of a programme for climate-change adaption in the region's forest and rangeland sectors.

This report, which was prepared for the workshop, will be a valuable resource for specialists, policy-makers, forest managers, students and members of the public who want to know more about the crucial task of adapting forests and rangelands to climate change in southern Africa.

## First textbook on forestry

*Sylvicultura oeconomica. Transkription in das Deutsch der Gegenwart.* H. Thomasius & B. Bendix. 2013. Remagen, Germany, Verlag Kessel. ISBN 978-3-941300-70-5.

The first textbook specifically about forestry, *Sylvicultura oeconomica*, also known as *Instructions about wild arboriculture* (Anweisung zur wilden Baumzucht), was published in 1713 by Hans Carl von Carlowitz, a Saxonian mining administrator (see *Unasylva* 240 for a detailed account of the influence of this book). Three reprint editions of the book have been published since 2000, and a scientific edition has also seen the light, although the latter was only a literal account of the original Baroque text in its Gothic script.

Now, two forest scientists, Professor Harald Thomasius (Tharandt) and Dr Bernd Bendix (Bad Schmiedeberg), have transcribed the original text into contemporary German with the aim of overcoming difficulties posed to contemporary readers by the elaborate Baroque language of the 18th century and its Gothic script.

The publisher and authors hope that this modern edition of *Sylvicultura oeconomica*, which is complemented by in-depth background information and a number of comprehensive indices, will make access to this 300-year-old publication as enjoyable and enriching as when it was first published.

*Verlag Kessel publications in German: www.forstbuch.de (Verlag Kessel publications in English: www.forestrybooks.com)*

# E-book on edible insects now available

The FAO Forestry Paper ***Edible insects: future prospects for food and feed security***, which achieved worldwide attention at its launch during the International Conference on Forests for Food Security and Nutrition, is also proving popular as an e-book.

***Edible insects*** describes the contribution of insects to food security and shows the many traditional and potential uses of insects for human consumption. Download it – and other selected FAO titles – to your iPad, Kindle, Nook or Sony Reader and highlight interesting passages, bookmark pages, make notes and search the full-text content with one click.

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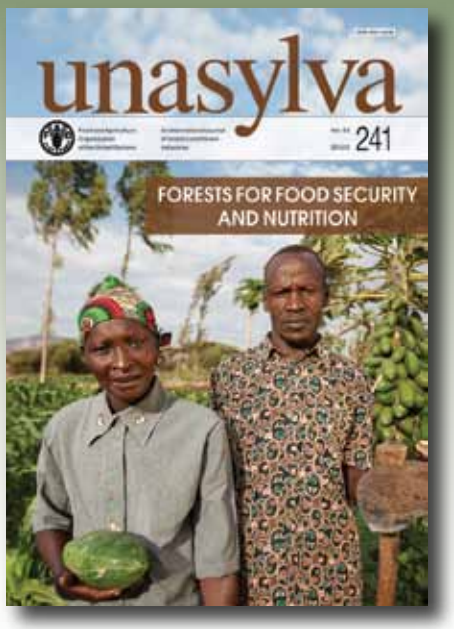


# *Unasylva* reader survey

At FAO we believe that ***Unasylva*** plays an important role in articulating the ideas, practicalities and challenges of sustainable forest management. But we want to know what you think. Please help us by participating in a short Web-based survey. We will use your responses to improve ***Unasylva*** and increase its impact in the development of effective forest policy and practice.

The survey will take 5–10 minutes to complete. Check it out at the ***Unasylva*** webpage today!

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